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TECHNICAL TRANSLATION

F-60

COMMUNICATION CONCERNING SCIENTIFIC WORKS IN THE FIELD OF GEOMAGNETISM AND AERONOMY DURING 1957-1959

Translation of report compiled by the Geomagnetism and Aeronomy Section of the Committee on Geodesy and Geophysics of the USSR Academy of Sciences; A. G. Kalashnikov, chairman. Published by the Academy of Sciences, USSR (Moscow), 1960.

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FOREWORD

This report is a short exposition of the basic researches in the field of geomagnetism and aeronomy carried out in geophysical institutions of the USSR during 1957 -- 1959. In the composition of this report data were used from the following organizations which did research in the field of geomagnetism and aeronomy:

Institut fiziki Zemli [Institute of Earth Physics] of the USSR Academy of Sciences (IFZ) - Moscow

Institut fiziki atmosfery [Institute of Atmospheric Physics] of the USSR Academy of Sciences (IFA) - Moscow

Institut zemnogo magnetizma i rasprostraneniya radiovoln [Institute of Terrestrial Magnetism and Radio Wave Diffusion] of the USSR Academy of Sciences (IZMIRAN) - Krasnaya Pakhra

Murmanskoye otdeleniye Instituta zemnogo magnetizma i rasprostraneniya radiovoln [Murmansk Department of the Institute of Terrestrial Magnetism and Radio Wave Diffusion] of the USSR Academy of Sciences (MO IZMIRAN) - Murmansk

Institut prikladnoy geofiziki [Institute of Applied Geophysics] of the USSR Academy of Sciences (IPG) - Moscow

Institut geofiziki [Geophysics Institute] of the Georgian SSR Academy of Sciences - Tbilisi

Magnitnaya laboratoriya [Magnetic Laboratory] of the USSR Academy of Sciences - Moscow

Leningradskiy gosudarstvennyy universitet [Leningrad State University] (LGU) - Leningrad

Geologicheskiy institut [Geological Institute] of the USSR Academy of Sciences (GIN) - Moscow

Vsesoyuznyy nauchno-issledovatel'skiy geologo-razvedochnyy institut [All-Union Geological Exploration Research Institute] (VNIGRI) - Moscow

Institut geologicheskikh nauk [Institute of geological sciences] of the Armenian SSR Academy of Sciences - Erevan

Krymskaya astrofizicheskaya observatoriya [Crimean Astrophysics Observatory] of the USSR Academy of Sciences (KrAO) - Simferopol'

Arkticheskiy i antarkticheskiy institut [Arctic and Antarctic Institute] (AANII) - Leningrad

Yakutskiy filial [Yakutsk branch] of the USSR Ac. of Sci. (YaFAN) - Yakutsk

Sibirskoye otdelenie [Siberian Department] of USSR Ac. of Sci. - Novosibirsk.

Vsesoyuznyy nauchno-issledovatel'skiy geologicheskiy institut [All-Union Geological Research Institute] (VSEGEI) - Leningrad

Moskovskiy gosudarstvennyy universitet [Moscow State University] (MGU) - Moscow

Fizicheskiy institut [Physics Institute] of the USSR Academy of Sciences (FIAN) - Moscow

Institut geologii poleznykh iskopayemykh [Institute of the Geology of Mineral Resources] of the Ukrainian SSR Academy of Sciences - L'vov

The report encompasses two large divisions of geophysics. The first division - geomagnetism and geoelectricity - includes a survey of research on the following subjects: magnetic observatories and earth current stations; main magnetic field; secular variations; magnetic properties of rocks and paleomagnetism; periodic variations of the geomagnetic field; geomagnetic and geoelectric disturbances; short-periodic vibrations of the magnetic field of the Earth and of earth currents; instruments and methods; information handbooks.

The second division - aeronomy - includes a survey of research on the following subjects: atmospheric electricity and the formation of precipitation; aurora polaris and the luminosity of the nocturnal sky; the ionosphere; cosmic rays (in their relationship to geophysics); the study of meteors.

For each of the subjects a detailed bibliography is given in addition to a survey of the work.

The report was compiled by the Geomangetism and Aeronomy Section of the Committee on Geodesy and Geophysics of the USSR Academy of Sciences.

Chairman
of the Geomagnetism and
Aeronomy Section of the
Committee on Geodesy and
Geophysics of the USSR
Academy of Sciences

Professor A. G. KALASHNIKOV

I. GEOMAGNETISM AND GEOELECTRICITY

1. Magnetic Observatories and Earth Current Stations

In connection with the IGY standard magnetic observations were organized in Ashkhabad, Kiev, Minsk and Tomsk. Questionnaires on all magnetic observatories of the USSR which were active during the IGY were prepared and sent to the No. 1 Committee of the International Association for Geomagnetism and Aeronomy and were published by it [1]. Two articles on the Tbilisi magnetic observatory were published in the USSR.

In one of them [2] the characteristics of the scientific role of the Tbilisi observatory in the study of earth magnetism phenomena is given.

In the other [3] information is given concerning the organization of the magnetic observatory in Tbilisi in 1844 and its transmission to Karsani in 1904 and to Dusheti in 1935; detailed characteristics of the scientific activity of these observatories are also given.

Besides the standard program of observations work was carried out on the collation of magnetic standards of observatories along with collations within the USSR, some international collations were made.

Main results given in table 1.

TABLE 1

Main results of collations of magnetic standard specifications for 1957-1959

Year of Collation	First Collation Point	Second Collation Point	Difference H "first" minus "second" point
1957	Moscow	Nimeg	-8
1958	Moscow	Nimeg	-11
1958	Moscow	Rude-Skov	-12
1959	Moscow	Grotska	-15
1959	Moscow	Sverdlovsk	-10.5
1959	Moscow	Tbilisi	-34
1959	Moscow/Gauss Lamon method/	Moscow/proton magnetometer/	-5

At the end of 1959 and the beginning of 1960 the equipment of the majority of magnetic observatories of the USSR was supplemented with proton magnetometers with measurement of the frequency of free procession by the pulsation method.

Until 1960 work on the adjustment of the electromagnetic theodolite for absolute measurements of T, H, Z, D and J, manufactured per order of the institute in East Germany, was continued by V. F. Shel'ting in the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Diffusion of the USSR Academy of Sciences. Measurements of one standard Helmholtz coil were completed. Measurement error does not exceed ± 0.5 micron given a coil diameter of 300 mm.

Many observatories in the USSR took part in the task of the S and K characteristics, as well as in work on the program of the No. 10 Committee of the Association.

At 5 stations the recording of short-periodic oscillations of the Earth's magnetic field was made with the aid of highly sensitive induction fluxmeter equipment. Data on fluxmeter stations are cited in table 2.

Recording of earth currents was done at 18 stations. A round-the-clock record was kept on a scan of 90 mm/hour and 30 mm/min. At 12 stations round-the-clock recording on a standard scan of 20 mm/hour was carried out. Basic information on the types of recording of earth currents at stations as well as work periods at the stations are shown in table 3.

Special highly sensitive apparatus for recording short-periodic oscillations was developed at the Leningrad State University. This apparatus was installed in 1959 at Borok station /φ = 58°02'N, λ = 38°20'E; in the Antarctic at Mirnyy station /φ = 66°33395' S λ = 93°E / and at Vostok station /φ = 78°27'S λ = 106°52'E /. In addition, observations on floating station SP - 6 were made in August 1959 by means of such equipment.

Following the example of former years the Tbilisi magnetic observatory published a yearbook of its observations for 1934 [4]. Besides numerical data in accordance with international form, an exposition of the results of analysis of two fixed basic series of magnetic varicmeters of the observatory at Karsani is given.

TABLE 2

Station	Geog. Coord.		Geomagn. Coord.		Component	Scan	Time period work begun	Remarks
A057 Lovozero IFZ USSR Ac. Sci.	67° 59'	35° 05'	62° 45'	127° 18'	Z	90 mm/hr	Jul. 1957	Periodic recording
						30 mm/min.	Jul. 1957	
					gradient Z	90 mm/hr	Nov. 1958	
					Hx, Hy	90 mm/hr.	Mar. 1959	
B014 Borok IFZ USSR Ac. Sci.	58° 02'	38° 20'	52° 53'	123° 02'	Z	90 mm/hr	Jul. 1957	Periodic recording
						30 mm/min	Jul. 1957	
					Hx, Hy	90 mm/hr	Feb. 1958	
					gradient Z	90 mm/hr	Sep. 1958	
C001 Petropavlovsk IFZ USSR Ac. Sci.	53° 00'	158° 39'	44° 24'	218° 14'	Z	90 mm/hr	Jul. 1957	Periodic recording
						30 mm/min	Jul. 1957	
					gradient Z	90 mm/hr	Nov. 1958	
					Hx, Hy	90 mm/hr	Dec. 1959	
C072 Dusheti Georgian SSR Ac. Sci.	42°05'	44°42'	36°35'	22°03'	Z	90 mm/hr	Jul. 1957	Stopped owing to industrial interference
						30 mm/hr	Jul. 1957	
							Nov. 1957	
C026 Crimean Astrophysics observatory (Partizanskoye)	44°50'	34°04'			Z	360 mm/hr	since 1955	

TABLE 3

Name of station	Geographic		Geomagnetic		Time station work begun per IGY program	End of station work	Type of recording (scan)			Start of recording		
	φ	λ	Φ	Λ			mm hr	mm hr	mm hr	90 mm/hr	22 mm/hr	30 mm/hr
1	2	3	4	5	6	7	8	9	10	11	12	13
Kheysa Island	80°37	58°03	70°54	156°29	10 Dec 1957		90	22	30	December 1957	May 1958	December 1957
Cape Chelyu-skin bNo.	77°43	104°17	65°58	176°24	15 Aug. 1957		90		30	August 1957		29 August 1957
Tiksi	71°34	128°54	60°08	191°08	15 Feb. 1958		90		30	Feb. 1958	October 1958	February 1958
Barents-burg	78°39	16°23	74°27	132°56	Oct. 1957	June 1959	90		30	October 1957		October 1957
Lovozero	67°58	35°05	62°45	127°18	July 1957		90	22	30	July 1957	May 1958	July 1957
Borok	58°02	38°58	52°53	123°02	July 1957		90		30	July 1957		July 1957
Shchatsk	53°59	41°51	48°32	123°48	July 1957		90	20	30	tapes July 1957	defective	
										August 1957	August 1957	October 1957
L'vov	48°33,2	22°23,8	47°00	104°09	July 1957		90		30	July 1957		July 1957

(Table 3 continued on page 7)

(Table 3 continued from page 6)

1	2	3	4	5	6	7	8	9	10	11	12	13
Petropavlovsk Kam	53°06	158°38	44°24	218°14	July 1957		90	22	30	July 1957	June 1957	July 1958
Irkutsk	53°04	105°32	41°19	175°28	Sept. 1957		90		30	March 1958		Sept. 1957
Yuzhno Sakhalinsk	50°50	142°10	40°24	205°15	1 Feb. 1958		90	22	30	Feb. 1958	March 1958	Feb. 1958
Alushta	44°41	34°25	40°56	113°36	April 1957		90		30	July 1957		July 1957
Alma-Ata	43°16	77°22	33°10	151°03	July 1957		90	22	30	July 1957	Sept. 1957	July 1957
Tbilisi	42°05	44°42	36°35	122°03	June 1957		80	22	30	July 1957		
Ashkhabad	37°57	58°06,5	30°21	133°03	July 1957		90	22	30	July 1957	July 1957	July 1957
Mirnyy	66°33 s.lat.	93°00 s.lat.	77°15	145°43	July 1957		90		30	July 1957		July 1957
Oazis	66°16	100°43	77°43	159°53	July 1957	Nov. 1958	90	20	30	Aug. 1957	Aug. 1957	Aug. 1957
Volozhin	54°06	26°31	51°26	110°31	1 Feb. 1958		90	22	30	February 1958		

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2. Main Magnetic Field

In May 1958 protracted and voluminous geomagnetic measurements [T modules] in a range of altitudes basically from 250 to 750 km. were carried out on the third Soviet artificial earth satellite. [1]. Analysis of observation data permitted us to draw a number of important conclusions concerning the geomagnetic field, in particular:

1) The field of world anomaly embracing the eastern part of the territory of the USSR decreases with altitude with the same speed as does the main geomagnetic field, which compels us to consider the location of the causes of this anomaly [and of all world anomalies in general] as coinciding in depth with the location of the causes of the main geomagnetic field.

2) The magnetometer noted numerous crossings of the ionospheric electric current systems.

In January 1959, on the first Soviet cosmic rocket and in September 1959 on the second Soviet cosmic rocket, geomagnetic measurements were made which showed (together with measurements of cosmic rays) the outer zone of the Earth's radiation, which in January 1959 was situated at a distance of 22,000 km from the center of the Earth, and in September 1959 at 16-17,000 km from the Earth. Analysis of data obtained and of the general conditions of the geomagnetic field permitted S. Sh. Dolginov and N. V. Pushkov to draw the conclusion that this zone and the extra-ionospheric electric currents flowing in it always exist, and not only during geomagnetic storms, and its distance from the Earth depends on the time which passed from the magnetic disturbance.

Moreover, magnetic measurements on the second Soviet cosmic rocket permitted us to determine that the Moon does not possess a magnetic field greater than that which matches 0.5% of the mean intensity of magnetization of the earth. In the same way the decisive argument in favor of the "dynamo" was obtained - the theory of the main magnetic field of the Earth, inasmuch as on the Moon, which doesn't have a nucleus similar to the earth's, no noticeable magnetic field has appeared.

V. I. Pochtarev published a work devoted to the exposition of the hypothesis proposed by him of world magnetic anomalies [2]. A short exposition of this hypothesis was published earlier [3]. In accordance with this hypothesis, world magnetic anomalies are connected with ferromagnetic properties of the upper layers of the earth's shell and the earth's crust.

V. N. Bobrov, using data on magnetic variations, studied the internal structure of the earth's shell and discovered the manifestation of horizontal heterogeneity of the shell with respect to electrical conductivity [4]. In particular, he concluded that at European longitudes the specific electrical conductivity of the shell is approximately twice as small as the specific electrical conductivity of the shell at Asian longitudes. Later V. N. Bobrov published other works in which he gave estimated of the methods developed by him of calculating the electrical conductivity of the shell of the Earth for various sectors of the globe. He showed the great differences in electrical properties of the shell in various sectors of the globe. [5], [6].

The non-magnetic research schooner "Zarya" in accord with the IGY program accomplished under the direction of M. M. Ivanov an extended 15-month voyage in the Atlantic and Indian ocean. While visiting a number of ports the personnel of the expedition made collations of magnetic standards by means of a QHM unit furnished by Committee No. 3 of the MAGA (bi director Laursen). In August 1959 the "Zarya" began its second international voyage in the Indian and Pacific oceans.

For the period from August 1957 to November 1959 the schooner covered a total of about 90,000 km carrying out while in operation measurements of the geomagnetic elements T, Z, H, and D.

Measurements in the Atlantic ocean were carried out along six profiles which intersect the ocean, as well as in the Indian ocean and Mediterranean sea. On the basis of he data received new magnetic charts will be constructed. They will doubtless be more reliable than those now available, inasmuch as magnetic measurements have not been made in the oceans since 1929 when the U. S. non-magnetic yacht "Carnegie" tragically sunk. The "Zarya's" data will also provide valuable information on secular changes which have taken place in the oceans during the last 30-40 years.

M. M. Ivanov's analysis of the results of the data from the "Zarya's observations showed that the magnetic field of the oceans is remarkably anomalous, reflecting the complex geologic history of the ocean's bottom and the deeper layers of the earth's crust.

A chart of the anomalies of the vertical component of magnetic field intensity for the territory of Trans-Caucasus [7] was constructed by M. L. Chelishvili on the basis of data from the General Magnetic Survey, from points of the secular course of the geomagnetic field and on the basis of data from terrestrial magnetic surveys during 1945-1954.

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3. Secular Variations

V. I. Afanas'eva and Yu. D. Kalinin have published an exposition of the method developed by them for the prognosis of secular geomagnetic variations for the next few years [1]. They divide the changes in average annual values of geomagnetic elements, observed at magnetic observatories, into two parts: 1) one dependent on changes from year to year in magnetic activity, 2) the other dependent on processes inside the earth. We can confidently forecast each of these two components for 5-10 years ahead.

B. M. Lyakhov compared the variability of secular geomagnetic variations with the seismic properties of the Earth [2]. He observed a coincidence of increased seismic properties and increased variability of secular geomagnetic variations.

V. P. Orlov compared the anomalies shown by him of secular geomagnetic variations in the Central Asian part of the USSR with the tectonic structure of the pertinent region [3, 4], observed the coincidence of these anomalies with deep tectonic fractures, with contemporary tectonic activity.

V. P. Orlov, in accordance with data systematized earlier under the direction of Prof. B. P. Weinberg, constructed a series of charts of isopores [izopor] of deviation for the years 1600, 1650, 1700, 1750, 1800, 1850, and 1930 and showed on these charts the well-known "western drift" of the geomagnetic field [5].

M. Z. Nodia and his co-workers published a work [6], in which the results are given of studies of secular variation at reference points located across and along the Great Caucasus range, approximately in the central part of it at distances of 10-15 km. between points. Measurements were carried out by means of field weights.

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Special mention must be made of the work of P. N. Kropotkin (38) on the connection between paleomagnetic and paleoclimatic data.

The last division includes work devoted to problems of geological correlation on various magnetic parameters (39, 40, 41).

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5. Periodic Variations of the Geomagnetic Field

In this division were published several works concerning daily geomagnetic variations of a statistical nature [1,2].

N. A. Katsiashvili published three works devoted to studies of variations in Tbilisi. In one work [3] 1028 calm days in the magnetic sense during the period 1933-1945 were examined in the light of data from the magnetic observatory in Karsani and Dusheti:

1) amplitude Sq of variations in the horizontal component with increase of solar activity is reduced;

2) Sq - variation H for 48% of the 1028 days studied has the form of a transitional type, 42% polar and only 10% equatorial;

3) seasonal distribution of the indicated types is such that the maximum number of cases of polar form Sq - is observed in summer, whereas the transitional together with the equatorial is observed in winter and at the equinox.

In the second work [4] the 27 day recurrence Sq of variations H in data covering 11 years for the period 1933-1945 from the magnetic observatory of Tbilisi (Karsani, Dusheti) was studied and it was determined that:

1) in these years there occurred cases of repeated recurrences in 27 day sequences of calm days which were observed especially often in years of low solar activity;

2) the number of recurring days and the lengths of the sequences for equatorial and transitional types taken together are greater than for the polar type.

Finally, in the third work [5] it is shown that Tbilisi lies in the transitional zone of change of the type Sq - of variations H on the antipodal (i.e. to the south of this zone variations take on an equatorial form, whereas to the north they take on a polar form).

It is shown that sometimes even on completely calm (in the magnetic sense) days in Tbilisi, there occurs along with polar and transitional types of variations, the equatorial type. On the basis of data from 33 magnetic observatories of the northern and southern latitudes it has been determined that the transformation of types Sq - of variations H basically is of a local character.

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6. Geomagnetic and Geoelectric Disturbances

V. I. Afanas'eva published an extensive report devoted to the study of the irregular part of the field of magnetic storms [1]. The regularities discovered through the data of Soviet magnetic observatories are explained by her with an account of the geometric relationships between the corpuscular flux and the globe. In particular, V. I. Afanas'eva has shown storms, linked by her with the "distant" passages past the Earth of corpuscular fluxes, without capture of their substance by the geomagnetic field.

N. P. Ben'kova in a small memorandum showed that the exceptionally intense magnetic storms of 1938-1948 almost all participate in the sequences of 27-day recurrences of storms [2]. This confirmed her conclusion published earlier.

V. I. Afanas'eva at the U Assembly of the SK of the IGY (Moscow, 1958) reported her results of studies of magnetic storms in the first part of the IGY [3]. It was noted by her that in some storms there is present the shortperiodic part of the Di - variations, and in others - there is no such part. In V. I. Afanas'eva's opinion this is connected with the mutual distribution in space of the corpuscular flux and of the Earth -- during a full envelopment of the Earth by the flux the character of Di is of one type; during an incomplete envelopment it is another.

S. M. Mansurov reported at the same Assembly on local characteristics of the Di field at Mirnyy (Antarctic), and has connected these characteristics with local electrical currents on Antarctica's littoral [4].

A. D. Shevnin also reported there the results of a statistical study of geomagnetic activity on the basis of data from Soviet observatories for the period January 1957 - September 1958. [5].

G. P. Berishvili published a work [6] devoted to the study of the characteristics of frequency distribution of sudden outbreaks of geomagnetic storms in time, with an account of the geographic location of observation points.

Basically, the results of the study confirmed facts known earlier (for example, the predominant appearance of sudden outbreaks in the summer months, etc.).

In the work explanations are given for the characteristics of frequency distribution of storms with sudden outbreaks from the viewpoint of the studies of Chapman and Ferraro.

N. S. Khvedelidze studied [7] the irregular N variations during magnetic storms. 23 magnetic storms were subjected to study on the basis of data from four magnetic observatories (Srednikan, Irkutsk, Yuzhno-Sakhalinsk, Tbilisi).

It was noted that:

N depends on the time of the storm and has an aperiodic character; N at the end of several hours after the start of the storm reaches a maximum after which is diminishes; moreover, the further south the observatory, the greater the diminution;

N has a clearly expressed daily motion on local time.

O. M. Barsukov using the method of superimposing epochs compared [8] the effects of flashes with geomagnetic activity by Kp - indexes. By the method of separate comparison by longitudes it has been established that the regions in which the flashes were observed are responsible for the disturbances connected with corpuscular fluxes. A lag time of 3-5 days has been determined.

In another work O. M. Barsukova [9] examined 1625 sequences of Kp - indexes for a 13 year period (1946-1958). The most disturbed days (10 in each month) were picked as zero-days in each sequence. It has been determined that in the sequences having increased disturbance for 8 days before (or after) a zero-day a tendency is observed toward a maximum of 11 days and a minimum of 8 days after (or accordingly before) the zero-day.

In sequences having an increased disturbance for 11 days before (or after) the zero-day, a tendency is observed toward a maximum of 8 days and a minimum of 11 days after (or accordingly before) the zero-day. The probability has been estimated of the indicated alternations, which are connected with the presence of three maximums of disturbance obtained by comparing Kp with the chromospheric flashes by the method of superimposing epochs.

O. M. Burdo published a work [10] in 1957 in which a series of rules unknown earlier was established for the occurrence of magnetic disturbances in high latitudes. Characteristics of geographical distribution of the variations was noted.

In 1958 M. I. Pukovkin completed a study of the determination of sources of magnetic coil-shaped disturbances [11]. On the basis of the analysis of observations of the magnetic field and of ionospheric data the locality of coil-shaped disturbances has been established and the height of the source of these disturbances has been determined.

R. A. Zevakina carried out an analysis of magnetic coil-shaped disturbances and the changes in the ionosphere connected with them [12]. Data from Murmansk for the years 1954-1956 have been used. Disturbances lasting up to 5 hours, with an amplitude of the horizontal component (H) exceeding 30 γ are being analyzed. For the given period 353 disturbances have been recorded. The daily and seasonal motion of the number of coils has been noted. Positive bays (H increases) were observed more frequently in the second half of the 24-hour period; the negative ones - in the first half. Negative coils were more often observed in summer; positive ones more often in winter.

The center of the currents causing the coils was located north of Murmansk.

The ionospheric changes during the coils consisted chiefly in an increase in the limiting frequencies of the ES layer, and sometimes (in 25% of the cases) - with full absorption. With the growth of magnetic activity anomalous changes in the F2 region increase.

At the V Assembly of the SK of the IGY (Moscow, 1958) R. A. Zevakina reported work on the connection between ionospheric and magnetic disturbances [13] on the basis of data from the observatory in Murmansk for the years 1954-1957. Anomalous changes in the ionosphere during magnetic storms and during coil-shaped disturbances of the magnetic field.

The author has drawn the conclusion that processes originating in the lower ionosphere chiefly at heights of 100 km are responsible for magnetic disturbances at high latitudes.

Another work by R. A. Zevakina on the same problem was submitted for publication in 1959 [14]. On the basis of observation data obtained in Murmansk in 1954-1956, the regularities of ionospheric and magnetic disturbances and the connection between them were examined.

Ionospheric disturbance became apparent in the anomalous absorption, growth of minimal frequencies, growth of limiting frequencies f ES, by the considerable change in the f ES frequencies. Most often anomalous absorption was observed in the growth of fES; moreover, in the daytime hours there most often occurred an increased absorption, and in the night hours the growth of f ES. Anomalous changes in the region (considerable deviation from the median Δf F 2) and the appearance of additional layers (they are observed more often at night). With the growth of solar activity there increases the frequency of cases of anomalous absorption (in summer).

Magnetic disturbances of greatest activity were achieved in the night hours. Three maximums of activity were noted: at 20-22 hours, at 2-3 hours and at 14-17 hours of zonal time. The beginning and end of ionospheric-magnetic disturbances are connected with local time: the beginning falls at 16-24 hours, the end -- at 0-8 hours. The greatest correspondence between anomalous changes in the ionosphere and the geomagnetic field was observed during the night hours: in the daylight hours wave radiation from the Sun equalizes the potentials in the ionosphere, which hinders the emergence of currents which are the cause of magnetic disturbances. Currents arising at altitudes of the order of 100 km are responsible for magnetic disturbances.

B. A. Aleksandrov, M. I. Pudovkin and B. M. Yanovskiy made a report [15] in which they gave an account at the V Assembly of the SK of the IGY (Moscow, 1958) of the preliminary results of a study of the morphology of the field of magnetic disturbances on the basis of data from permanent magnetic observatories and from a number of temporary magnetic observatories which worked for several years in the northwest Asiatic part of the SSSR. A chart was constructed of isolines δH and δZ for a number of storms and it was shown that the principal direction of the gradient of intensity is meridional, whereas the change in intensity of disturbances in the latitudinal direction has a considerably smaller gradient and is of a more uniform character. This permits us to assume that the ionosphere currents responsible for the field of disturbances have to form akin to the linear and stretched out in a latitudinal direction. Moreover, the lines of currents during a storm may be displaced in a meridional direction.

Comparison of magnetic and ionospheric disturbances on the basis of data from "Mirnyy" station (Antarctic) showed that the rapidly moving clouds of the sporadic layer E S are evidently the source of magnetic disturbances.

In the work of M. I. Pudovkin [16] the results are written up of a study of separate coil-shaped disturbances on the basis of data from a number of magnetic variation stations which worked simultaneously at relatively small distances from each other in the northern part of Western Siberia and in the summer of 1953, 1954, and 1957.

A method was given for the division of the observed field into external and internal parts and formulas were given for the calculation of the parameters of ionospheric currents responsible for coil-shaped disturbances on the assumption that these currents have the form of homogeneous flat current layers.

It is further shown that by the displacement of the centers of the magnetic disturbances we can judge the winds in the ionosphere, the speed of which according to the author's data turned out to be equal to $\sim$ 120 m/sec.

The connection between the direction of the ionospheric wind, permanent field of the Earth and field of disturbances happens to be such that it is easily explained by the dynam—theory and is explained only with difficulty from the standpoint of other theories.

Comparison of magnetic data with data from ionospheric stations on Dikson Island and in Tiksi Bay confirms the movement of ionospheric inhomogeneities with speeds obtained by magnetic data.

More than 10 works have been published by A. P. Nikol'skiy. In two of them [17, 18] it is shown by data from observations from 28 stations with a geomagnetic latitude greater than 60°, that the isochrones of the occurrence of the morning maximum of magnetic disturbances, which have been related to world time, are a system of spirals which expand in accordance with the hour hand and which emerge from the pole of homogeneous intensity of magnetization. The assumption is stated that in the near-polar region of the Arctic there is a second zone with increased frequency and intensity of magnetic disturbances and of auroras polaris. Its form and position is given approximately. Arguments are cited from observations of other phenomena dependent on solar corpuscles. It is assumed that morning magnetic disturbances are caused by intrusions of solar protons.

In one work of A. P. Nikol'skiy [19] the connection is examined between the geographic distribution of morning magnetic disturbances and the anomalous absorption of radio waves in the ionosphere of high latitudes. Analysis of the data confirms the assumption concerning the existence near the pole of a second zone with increased frequency and intensivity of magnetic disturbances and auroras polaris.

The works of A. P. Nikol'skiy [20,21] are devoted to the problem of the geographic distribution of magnetic disturbances in the Antarctic. Proceeding from Shtermer's theory and the results obtained for the Arctic the assumption is stated that the isochrones of the morning maximum of magnetic disturbances in the Antarctic must be spirals emerging from the pole of homogeneous intensity of magnetization and expanding against the hour hand.

A system of isochrones for the morning maximum has been laid out for the Antarctic, and a symmetrical system has been found for the Arctic. It has been shown that available data from observations in the Antarctic do not contradict this schematic picture. Data obtained later from observations from magnetic stations which worked in the IGY program (Mirnyy etc.) are in accord with the system of isochrones which have been laid out.

In two works of A. P. Nikol'skiy [22,23] attention has been given to the fact that a number of phenomena in the course of magnetic disturbances agree with Shtermer's conclusions. From Shtermer's theory it follows that on the spiral of precipitation of the solar corpuscles (protons) there must exist regions of condensation of the trajectories which fall at 14, 20, 02 and 08 hours local geomagnetic time. These regions are called regions A, B, C, and D, respectively. The rotation of the Earth under the spiral of precipitation of corpuscles, on which there are the above mentioned four regions, leads to the formation of four annular zones in which increased activity of magnetic disturbances and auroras polaris must be observed. An assumption is made that zone

D nearest to the pole is something other than a second zone which was discovered earlier independently, and that the first zone of the aureoles - the Fritz zone - is the overall B and C effect of Shtermer's zones. On the basis of data from the observations the position of these four zones on the earth's surface has been determined.

In another work of A. F. Nikol'skiy [24] the author states his new opinion concerning magnetic disturbances. The author has drawn a new conclusion to the effect that both morning and nocturnal non-regular magnetic disturbances are caused by irruptions of the solar protons in the upper layers of the earth's atmosphere.

One work of A. F. Nikol'skiy [25] is devoted to the study of magnetic storms in Tikhaya bay for the period from 1934 to 1952. The storms, recorded in Tikhaya, were divided into two classes: 1) cosmic storms noted both in high and in medium latitudes, 2) polar storms which were observed only in Tikhaya but are not observable in the medium latitudes. It has been shown that magnetic storms of these two classes have a different seasonal and cyclical course. Both classes of storms display a tendency to 27-day recurrence. The condition of the ionosphere in Tikhaya bay does not in its average characteristics display well marked and systematic differences on days with cosmic and polar magnetic storms.

The conclusion is being reached that phenomena which cause the emergence of polar storms are localized principally in the near-polar region, to the north of Tikhaya bay, whereas phenomena responsible for cosmic storms are located in the zone of maximum auroras polaris and partially even in lower latitudes. The characteristics observed in the course of these two classes of storms depend on the localization of the irruptions of the corpuscles in the upper layers of the earth's atmosphere.

One work of A. F. Nikol'skiy [26] is devoted to an analysis of magnetic activity using K-indexes. Data were studied from 26 stations for the month of the storm - August 1943,, for 5 stormy days of August 1955 and for 49 stations over 60 stormy days for all months of 1955.

The author drew the conclusion concerning the presence of a definite longitudinal effect in the average intensivity of the magnetic activity. The assumption was stated that the presence of the longitudinal effect can be explained on the basis of the possible existence of four zones of increased magnetic activity.

One work of A. F. Nikol'skiy [27] is devoted to problems of the technique of investigating magnetic disturbances. Problems are examined connected with the physical interpretation of the results of statistical averaging. Special attention is given to an examination of the statiscal averaging of irregular disturbances. It is indicated that two types of phenomena may be met. For some phenomena the average statistical daily course if free from the effect of irregular disturbances in other phenomena; the form and amplitude of the average daily course as a whole is determined by the frequency of appearance of irregular disturbances of different intensity. Magnetic disturbances belong to the latter type of phenomena.

In this connection the problem was discussed of the applicability for investigation of the daily course of magnetic activity (and other similar phenomena) of such formal mathematical methods as harmonic and spherical analysis, and the conclusion was reached that the application of such mathematical methods, but which do not correspond to the physical nature of the phenoma of magnetic disturbances, cannot be considered useful. Examples of some other geophysical phenomena are being examined. A possible criterion is given for determining which type of phenomena the given geophysical phenomenon can be related to.

P. K. Sen'ko published the results of a study of magnetic variations in the Central Arctic determined by aerial expeditions in 1948-1950 and by floating station SP-2 during 1950-1951. [28].

Analysis of daily variations confirmed the assumption concerning the possibility of the existence in the near-polar region of a second zone with increased magnetic activity. Maps of isoamplitudes of the daily course for the H component of the field and for deviation were made more precise. The chief characteristics of the daily X Y variations and of the components of the magnetic field for the eastern sector of the Central Arctic. The revolution of the phase of the daily course of X remaining in the eastern sector of the Arctic at geomagnetic latitudes 72-74° was noted.

N. A. Milyayev studied [29] the variations of magnetic disturbance on the basis of data from observations from floating stations "North Pole - 3" and "North Pole - 4" (1954-55). It was shown that in the near-polar region the average level of magnetic activity in 1954-1955 was almost half the activity observed in the same period at stations located near the zone of maximum auroras polaris. The principal role in the formation of the average level of magnetic disturbance in the near-polar region belongs to morning and daytime disturbances. Magnetic disturbance in the near-polar region is greatest in summer. In winter the disturbance is 2-3 times weaker than in summer and varies little in the course of a twenty-four hour period.

Ya. I. Fel'dshtein and E. I. Kurdina studied [30] the simultaneous variations of elements of the magnetic field in the observatory at Dikson Island (φ - 73.5°N; λ = 80.4° E) and at points: Sopochnaya Karga φ - 71.9° N; λ = 82.7° E), Ust'e-Tareya (φ ± 73.2° N; λ = 88.8°E) as per data in May and June 1956. It was shown that the general character of variations of the magnetic field at a latitudinal distance of 180 km. and a longitudinal distance of 300 km. is one and the same. The greatest difference in form and phase of the variations is observed at the vertical component. At a distance between points of 800 km. Z variations are often found in the antiphase.

In the work of O. A. Burdo [31] the problem of the relationships of regular and irregular variations of the geomagnetic field at high latitudes is examined. It has been established that disturbances of the magnetic field at high latitudes during cosmic storms is determined on the whole by polar storms. Regular geomagnetic variations S_D and D_{ST} in polar regions are created entirely by polar storms. A study of the daily motions of the projection of the vector of the disturbed field onto the horizontal plane and of magnetic activity, carried out on the basis of observations of a greater number of high-latitude stations, showed that the sources of the disturbed field are located on three spirals corresponding to the morning, evening and nocturnal maximums of magnetic disturbance. An attempt was made to explain this regularity from the standpoint of the dynamo - theory of magnetic disturbances. A system of currents flowing in the ionosphere was constructed, which is responsible for the observed distribution of the disturbed magnetic field on the Earth's surface.

In the work of G. N. Egorov [32] the results of observations of magnetic observatories of the Soviet sector of the Arctic are analyzed. It was established that the geographic distribution of geomagnetic disturbance depends on the time of day, the season, the phase of solar activity and the intensivity of the disturbance. A disturbance in the period of weak storms increases monotonously with the increase of geomagnetic latitude, without disclosing the maximum in the zone of auroras polaris. Severe storms in winter have one maximum in the zone of luminescences, and in summer two maximums: one close to $\Phi = 63^o$ and the second around $\Phi = 71.5^o$.

A group of works published in 1957-1959, devoted to problems connected with the study of the general characteristics and to the disturbance of the field of terrestrial currents, as well as to a number of problems of method connected with observations of earth currents.

In the work of V. V. Kebuladze [33] the author arrives at the following:

1) The technique of field studies based on the utilization of long-period variations and electrotelluric disturbances has a number of advantages over the technique based on the utilization of short-period oscillations.

2) For the determination of electrotelluric parameters, daily records are more reliable than short-term ones.

3) The utilization of long-period variations increases the depth of the survey.

4) An electrical survey of larger territories must be carried out simultaneously using several electrotelluric apparatus.

5) To get reliable and comparable records the recording apparatus and the electrotelluric equipment must be identical at the base and at movable points.

V. V. Bukhnikashvili, V. V. Kebuladze and A. S. Lashkhi examined [34] the possibility of utilizing electrotelluric currents to solve several problems of structural geology. The Voenno-Gruzinskaya [Georgian Military] road and the Kartilyskaya plain were the objects of the study.

It was established by measurements that a very complex and difficult-to-interpret picture is obtained along the Georgian Military road.

For geological structures of the type of the Kartliyskaya plain, i.e. with the presence of comparatively highly condictive rocks, under which high-resistant formations are found, the studies which were made proved the possibility of studying them both on the basis of the records of short-periodic variations and on the basis of data on the daily motion, the authors having preference for the latter method.

The following are given in the work of V. V. Kebuladze [35]:

1) a catalog of long-lasting electrotelluric storms and disturbances noted in Dusheti from 1948-56 and their basic characteristics;

2) tables of hourly three-point characteristics of the activity of the electrotelluric field for the years 1951-56;

3) results of statistical processing of round-the-clock records of terrestrial electric currents for the years 1951-55, carried out by the author in order to study short-periodic oscillations of the type Pc and type Pt.

On the basis of analysis of these data illumination has been shed on problems of the daily, seasonal and annual motion of the above-indicated disturbances and oscillations. It is shown that when sufficient data for statistical processing is available, periodicity and other regularities occuring during electrotelluric disturbances are clearly shown by the three-point hourly characteristics and data from the catalog.

In the work of A. S. Lashkhi and G. E. Cugunava [36] data are given concerning the distribution of electrotelluric disturbances in connection with a latitudinal change of intensivity of cosmic irradiation when comparing Feror's zones with the course of electrotelluric disturbances in Dusheti; the authors suggest that there must be a connection between these phenomena. To check this assumption disturbances of the electrotelluric field were compared in Dusheti and Shatske, located at different latitudes.

For a quantitative analysis of the possible connection the coefficient of correlation for the disturbed hours at the two above-mentioned points was calculated.

The coefficient of correlation has a high value.

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In years of high solar activity the whole picture is less clear owing to interference from other heliophysic factors, whereas the dependence of the quantity of disturbances on Feiror's zones becomes clearer when there is a reduction of solar activity.

In an article of V. V. Kebuladze and A. S. Lashkhi [37] problems are examined concerning observations of variations of terrestrial currents in accord with the IGY program. A detailed description of the recording apparatus, underground lines and electrodes used in Dusheti is given. The results of processing tellurograms in 1957 are given. The basic characteristics of the disturbed field and several special types of short-periodic variations are given.

The principal results of studies of earth currents in Georgia for the last few years were reported by V. V. Kebuladze in 1958 at Tbilisi [38].

V. V. Kebuladze published [39] a list of the problems and topics recommended by the Interdepartmental Committee of the IGY, in the elaboration of which the Institute of Geophysics of the Georgian SSR Academy of Sciences is participating.

The results are given of the elaboration of individual questions on these problems and topics in the Institute of Geophysics of the Georgian SSR Academy of Sciences.

In an article by A. V. Bukhnikashvili, V. V. Kebuladze and T. L. Chelidze [40] a number of problems were clarified concerning a deep survey of geological structures by means of long-periodic variations of telluric currents. On the basis of data from a preliminary survey of large territories of Eastern Georgia curves of the electrotelluric parameter have been constructed and compared with data from deep seismic sounding (GSZ - glubinnoye seysmicheskoye zondirovanie), gravimetry and magnetic surveying. A good correlation between these data was established. The constructed chart of isolines of the telluroparameter gives a graphic presentation of the morphology of the covering of the crystallic base, which is confirmed by the results of GSZ and by the Δg chart.

A method for processing tellurograms by means of frequency analysis is proposed. Experimental work carried out by this method gives satisfactory results.

In the work of V. M. Mishin and O. M. Barsukov [41] the daily course of disturbance of terrestrial currents is compared with the daily course of magnetic disturbance on the basis of K* indexes. A satisfactory coincidence of daily courses has been established both for the first and for the second harmonics of the daily courses. It has been established that data concerning the daily course of disturbance of earth currents agree with the schematic for the presentation of the daily course of disturbance proposed earlier by V. M. Mishin.

In the work of O. M. Baruskov [42] daily E - indexes are introduced, as the ratio $\frac{E}{Q}$ where E is the maximum amplitude, the mean for the twenty-four hour period, and Q is the maximum mean amplitude for the year. It is established that E characterizes the planetary character of the disturbance and almost does not depend on the geographic position and geologic-geophysic conditions of the point of observations. The coefficient of correlation for the month with the planetary K - indexes, as well as C - characteristics > 0.9. The advantages of the E - indexes in comparison with K and C indexes are discussed. The assumption is stated concerning the possibility of introducing E indexes for shorter time intervals.

In other works of O. M. Barsukov [43, 44, 45] instances are noted of the simultaneous emergence of oscillations of identical form at Arctic, medium-latitude, and Antarctic stations. The relative amplitudes and the prevailing directions of the oscillations for Antarctic stations are stable. The mean maximum amplitude (for a 6 month period) for Mirnyy station is 749 mv/km; for Oasis station 814 mv/km.

The daily course of disturbance for Mirnyy station and Oasis station has one maximum of around 7 hours of cosmic time. The daily course of prevailing directions for Mirnyy and Oasis stations has been determined. In the work [44] it is shown that the daily course of the directions is not similar for different stations either in local or in cosmic time.

In the work of L. N. Baranskiy and N. L. Naumenkov [46] there is given a brief rundown of the equipment for recording terrestrial and marine electric currents at Mirnyy and Oasis stations, as well as a device for recording short-periodic variations of the magnetic field. Typical peculiarities of interferences caused by snowstorms, and the methods of combatting these interferences, are examined. The general features of the field of earth currents at Mirnyy and Oasis stations is given. Its linear polarization at both stations is noted; moreover, the direction of polarization of the vector of intensity of the telluric currents at Mirnyy station coincides with the direction of the shore line. Also noted is the anomalously large size of variations in the plane of marine currents at Mirnyy station which attain a value of 10^{-2} a/m^2.

It is assumed that the presence of these anomalous currents explains the complete similarity of variations of marine currents with an irregular part of the variations of the vertical component of the magnetic field, which is observed at Mirnyy station.

In the work of Barsukov O. M. and Zybin K. Yu. [47] experimental data on the prevailing directions of the vectors of variations E and H of the electromagnetic field of the Earth. Non-perpendicularity of the

E and H is explained by the presence of horizontal anisotropy in the rocks at the observation point.

In a separately published brochure of O. M. Barsukov and V. A. Troitskaya [48] a description is given of the standard apparatus of 18 Soviet earth current stations which made observations under the IGY program.

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7. Short-Periodic Oscillations of the Earth's Magnetic Field and of Earth Currents

In connection with the IGY there was organized in the Soviet Union a special network of stations (including those in the Arctic and Antarctic), conducting observations of short-periodic oscillations of the Earth's electromagnetic field (see Tables I and 2). The first results of the processing of these observations were reported at the Fifth Assembly of the SK [Soviet Committee?] of the IGY during June-August 1958 and were presented at the International Symposium on short-periodic oscillations (September 1959, Utrecht).

In the work of V. I. Afanas'eva [1] results are given of studies of short-periodic oscillations in the geomangetic field (having periods from 30 to 240 secs.) on the basis of data from USSR magnetic observatories over a number of years from 1938 to 1954. In this work the problem of the daily distribution of KPK (korotkoperiodicheskie Kolebaniya) short-periodic oscillations is examined, and a number of short-periodic oscillation correlations with ionospheric parameters and with parameters of solar activity is examined; also, some results of the author's theoretic calculations are given. The chief conclusion of the author is that short-periodic oscillations of the type Pc are created by the effect on the Earth's outer atmosphere of the inter-planetary medium, and those of type P_t by the effects of corpuscular fluxes.

A. G. Kalashnikov and E. N. Mokhova [2,3] published the results of processing cases of the simultaneous emergence on USSR territory of oscillations of the vertical component and horizontal component of terrestrial currents; some regularities of the appearance of such oscillations were studied in relation to geographic distribution and correlation of the amplitudes of the magnetic and electric field. Hypotheses were stated concerning the origin of these oscillations.

A. G. Kalashnikov in a special article [4] described the plan, which is being fulfilled by way of carrying out the IGY program, for the observation of short-periodic variations of the electromagnetic field at Borok, Lovozero and Petropavlovsk Kamchatka stations as well as at others; the apparatus used and some results of the study of these phenomena are described.

In an article of A. G. Kalashnikov [5] the scientific and practical value of the study of rapid pulsations of the Earth's electromagnetic field is stated; the content of the work of the International symposium on this type of geo-electromagnetic variations, which took place during April-May 1957 in Copenhagen, is given.

A. G. Kalashnikov and K. Yu. Zybin published [6] some results of observations of the vector of variations in the horizontal components of the Earth's electro-magnetic field (on the basis of IGY observations).

In this work were described some regularities of the behavior of the horizontal vector of short-periodic oscillations in the magnetic field and of terrestrial currents on the basis of observations at Borok station. The daily course of rotation of the vector has been established, as well as its prevailing direction, perpendicularity of the magnetic and electric vectors of the variations.

In the works of M. I. Berdichevskiy, B. B. Bryunelli, A. N. Iantsov and O. N. Raspopov [7] results are given of short-periodic oscillation observations using the micro-variation station of the Leningrad State University and the possibilities of using these observations for the study of the upper layers of the atmosphere are described.

During 1958-1959 new methods of geophysical reconnaissance of the upper layers of the earth's crust (magneto-telluric profiling (MTP) and magneto-variation reconnaissance (MVR)) were tested by the department together with the VNIIGeofizika [Vsesoyuznyy Nauchno-issledovatel'skiy institut geofiziki - All Union Scientific Research Institute of Geophysics] using this apparatus [8]. These works fully confirmed the theoretical bases of these methods.

In the report of V. V. Kebuladze [9] presented at the international symposium at Utrecht, light was shed on problems of the effect of local factors and the difficulties connected with this when isolating and classifying disturbances of the electrotelluric field. The basic characteristics of electrotelluric storms and disturbances recorded at the Dusheti station for earth currents during 1948-1958 are given. The following are subjected to detailed study: a) electrotelluric storms and disturbances of long duration, b) short-periodic disturbances of the type Pc, and c) oscillations of the type Pt.

Light is shed on problems of the daily, seasonal and annual course of the above-mentioned disturbances. The problem of the secular course of activity of the electrotelluric field is also examined. The exceptional amplitude characteristics pc and pt are given.

In the work of P. K. Sen'ko and V. A. Troitska [10] there is a description of the organization of the first observations of earth currents in the Antarctic. Information is given on the backing [zakladka] of the electrodes, on the receiving lines, and on the recording equipment. The effectiveness of observations of earth currents in the Antarctic for the study of a number of phenomena of the Earth's electromagnetic field is shown, in particular, for short-periodic oscillations. The amplitudes of the basic disturbances of the field of earth currents in Mirnyy (on the basis of one component) are estimated and the typicalness of stable oscillations for the Antarctic is revealed. The daily course for disturbance of the field of earth currents is deduced, as well as the daily course for stable oscillations and for group [tsug] of oscillations. Examples are cited of simultaneous activation of the short-periodic oscillations in the Antarctic, and at medium latitudes in the Arctic.

In the works of V. A. Troitskaya [11, 12, 13, 14] detailed results are cited of the processing of records of earth currents for the period July-December 1957 at Oasis and Mirnyy stations, as well as for two months of 1958. Results were given of a study of the daily course of earth currents, the disturbance of short-periodic oscillations (pc, pt and beads), disturbances of the coil type, of sudden outbreaks and impulses. The prevailing direction of the stream of earth currents at Oasis and Mirnyy was studied. Primary attention was given to the results of the short-periodic studies. A new important fact of the dependence of activation on the season was established for stable oscillations (Pc). For Pc the effect of the polar night has been discovered, which expresses itself in the sharp drop in the number of hours with Pc in the middle months of the polar night. The consequence of this effect is the dependence of the geographic distribution of Pc along the earth's surface on the season. Characteristic polar oscillations with periods from 6 to 15 secs. are shown, revealing the correlation with the auroras polaris.

Groups [tsugi] of oscillations in their characteristic form are not typical for the Arctic and Antarctic in the period of maximum solar activity.

The connection between activation pt in medium latitudes and polar activations in the Arctic and Antarctic is complex and variable. The daily and seasonal variations Pc, Pt in the Arctic and Antarctic are similar to their variations in the medium latitudes.

In the work of B. A. Troitska [15] concerning the microstructure of magnetic storms in accordance with short-periodic oscillations, additional characteristics are given for the classification of storms, permitting us to isolate special periods for which a correlation with the disturbed periods in the upper atmosphere is observed.

The microstructure was specially studied in accordance with short-periodic oscillations for sudden outbreaks, and it shows that the impulse ssc is usually accompanied by 2-4 oscillations with periods which are confined within a interval of 8-15 secs.

V. A. Troitskaya, M. V. Mel'nikova [16,17] published the results of a study of the characteristic short-periodic oscillation intervals which decrease by periods ($T \sim 10$-1 sec.). The moments of activation of these characteristic intervals coincide with the moments of activation of auroras polaris in low latitudes and with the moments of the outbreak of severe disturbances in the ionosphere. A clear manifestation of KUP [kolebaniya ubyvayushchikh po periodam - oscillations diminishing by periods] intervals, which are activated, possibly, on cosmic time, is observed in preliminary data within 6-8 time zones for which evening, night and early morning take place.

V. A. Troitskaya in a work [18] gives the first results of the study of a new, previously unknown type of KPK - oscillations of the type of pulsations (beads) with periods of $T \sim 1$-4 sec. These oscillations can arise as separate bumps with a duration of 1-2 minutes, or as continuous series of oscillations of the type of pulsations with a stable period, lasting for ten minutes. Oscillations of the type of pulsations were studied through round-the-clock records of earth currents with a development of 30 mm/minute on the network of IGY stations in the USSR.

Beads comprise one of the characteristics elements of the microstructure of magnetic storms for KPK; however, they can be activated on calm days too. It is very probable that the activation of the beads is controlled both by local and by cosmic time.

In the work of E. Zubareva, G. Korobkova, N. Nikitina, and V. Troitskaya [19] results are given of a study of huge pulsations on the basis of standard records of the magnetic field at 6 arctic observatories for the period 1935-1956 (Dikson, Uellen, Matochkin Shar, Tiksi, Chelyuskin, Tikhaya Bay); results are given of an analysis of the daily and seasonal courses of huge pulsations, as well as their distribution by periods and amplitudes. Data have been obtained which testify to the limitation of the diffusion of GP [gigantckie pul'satsii - huge pulsations] not only to the south of the zone of auroras polaris but also to the north of it. Instances were discovered of the activation of GP in a large ($\sim 110^{o}$) longitudinal interval. These instances are rare. F

In an article of R. V. Shchepetnov, M. V. Okhotsimskaya, Yu. B. 6
Rastrusin and I. I. Rokityanskiy [20] results are cited of a study of 0
short-periodic oscillations of the type pc and pt at four medium-latitude stations (Alma-Ata, Borok, Alushta, Petropavlovsk-Kamchatka). Data from the observations have been generalized for the period of the IGY. In this work are shown the regularities of the daily and seasonal courses of oscillations Pc and Pt for the stations listed above and the dependence of the activation of these oscillations on local time is established.

V. G. Dubrovskiy [21] presented a report at the symposium on KPK at Utrecht on rapid geoelectric and geomagnetic variations and their regularities basis on observations in Ashkhabad for the period from January 1956 to December 1958. In this work results are given of an analysis of oscillations of the type pc and pt with a division of the static oscillations into regular and irregular oscillations. Amplitude and frequency distributions of pc and pt are given. In this work results are given of an analysis of oscillations of the type of beads (pp) at Ashkhabad station for the period from July 1957 to March 1959.

In the works of E. Zubareva and N. Nikitina [22,23] the first results are given of a study of the general characteristics of the field of earth currents and of short-periodic oscillations of earth currents in the Arctic (Tiksi and Barentsburg stations). Charts are given of the daily and seasonal course for disturbances and oscillations of a different type, including those for Pc, Pt and beads. For Tiksi station results are given of a comparison of disturbances in earth currents with other geophysical phenomena (in press).

In a work of A. S. Dvoryashin [24] results aregiven of a study of the KPK of the Earth's magnetic field during magnetic disturbances and, particularly, of sudden outbreaks; the considerations are stated concerning the possible nature of the oscillations observed, which are explained as a result of the formation of a stationary wave between magnetically connected points of the northern and southern hemispheres of the Earth. The attenuation of the waves when passing through the ionosphere is examined.

O. V. Bol'shakova, K. Yu. Zybin and N. F. Mal'tseva [25] published several regularities in the behavior of the vertical component of KPK of the geomagnetic field of a stable system [rezhim] (Pc). In this work results are described of the processing of the stable KPK's of the magnetic field for the first six months of the IGY. The prevailing periods of oscillations, the daily courses for the number of cases of appearance and medio-maximum amplitudes of oscillations of various periods, as well as the seasonal variability of the daily courses and the frequency spectrum have been established.

To explain general regularities the "activity in the KPK" has been introduced and its daily and seasonal courses have been examined.

In the work of A. P. Vinogradov results are given of a study P_c and P_t in Irkutsk for 1957-59; data are given for the daily and seasonal courses of P_c and P_t; results are given of the comparison of data obtained with data from Japanese and Western European stations, as well as a number of other problems [26].

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8. Instruments and Methods. Handbooks and Textbooks

In the IFZ [Institut fiziki Zemli - Institute of Earth Physics], of the USSR Academy of Sciences jointly with IZMIRAN of the USSR a three-component quartz microvariation magnetic station has been developed which is intended for continuous recording of the microvariations of the Earth's magnetic field with an amplitude capacity up to several hundredths of a gamma (10^{-7} oersteds) and a frequency capacity up to 0.5 ehrtz.

Since 1958 a microvariation station has been set up for continuous recording of variations of the geomagnetic field (speed of scanning 90 mm/hour) at the geophysics station "Alushta".

A description of the station is given in the work [1].

Bryunelli B. E., Berdichevskiy M. N., Alekseev A. M., Burdo O. A. developed a design for a highly sensitive apparatus for recording short-periodic oscillations of the geomagnetic field. [2]. The complete unit of the apparatus in question includes three short-periodic highly sensitive magnetometers (H, D and Z - components) of B. E. Bryunelli's system, a control panel and 3 galvanometers and a recording device [registrir].

The highly sensitive variation station of Leningrad State University is calculated to record continuously during a 24 hour period the micropulsations of the geomagnetic field and has its own cycle of 5 to 600 seconds. The sensitivity of the apparatus is up to 0.01 γ /mm. Scanning speed is 6 mm/min.

B. E. Bryunelli, D. A. Nizyayev, Kh. D. Kanonidi [3] published a description of the equipment for the compensation in some volume of variations of the magnetic field using a magnetometric device and a photoelectric amplifier.

S. M. Mansurov published a large work on the theory of magnetic variation devices [4], in which the theory of the unifilar magnetograph, with vertical or with horizontal axis of rotation of the magnet, the theory of the bifilar magnetograph, and of magnetic weights is stated in a systematic form. Problems of errors owing to incorrect equipment, means of changing the sensitivity of the variometers, the effect of the temperature on variometer readings, means of temperature compensation, problems of the reciprocal effect of variometers and other problems have been examined.

L. G. Mansurova published a work on quartz H-magnetometers [5] in which are given the theory of the instrument, the technique of tuning the instrument, the order of determining the constants of the instrument and the order of work with it when determining H and D.

Yanovskiy B. M., Studentsov N. V., Tikhomirova T. I. published a description of the new equipment for measuring weak magnetic fields of the order of the earth's using nuclear resonance. With the help of this equipment the intensity of the magnetic field can be measured in Helmholtz coils with a radius of 15 cm., where the size of the homogeneous field amounts to 8 cm.^{3} Having measured the field in specially manufactured (with high accuracy) Helmholtz coils we can determine the size of the gyromagnetic ratio. The results of the first experiments gave a magnitude $\gamma = (2.67520 \pm 0.00015/10^4$ sec.$^{-1}$ oersted^{-1}. [6].

Yanovskiy B. M., Sokolova E. A. [7,8] published a description of a new device for measuring magnetostricture as functions of intensity of magnetization and of the magnetizing field at various temperatures (from 180° to + 450°C). The apparatus is intended for the measurement of the phenomena of magnetostricture both of ferromagnetic alloys and ferromagnetic rocks and permits us to measure the relative elongation from 10^{-7} to 10^{-4}.

S. S. Piontkovskiy published a description of a "penetration meter" ["pronitsmer"] on crystal triodes [or transistors] [9].

A description of a new apparatus for measuring residual intensity of magnetization is given in the works of V. V. Kochegur [10]. V. A. Dianova-Klokova [11]. The works of G. M. Avchyan [12, 13, 14], M. I. Ozerskaya [15, 16], S. P. Burlatskaya [17] are devoted to the improvement of the technique of measurements on Dolginov's magnitometer.

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II. AERONOMY

1. Atmospheric Electricity

A. Study of the Electricity of Good Weather. Electric Field Potential Gradient and Conductivity of the Atmosphere

Experimental and theoretical studies were made of the general regularities of change in the electric field potential gradient (1,2,3) and in the conductivity of the air (4,5) at various points in the Soviet Union and at various altitudes.

The connection between the change of atmospheric-electric parameters and earthquakes (6) and meteor fluxes has been studied (7).

B. Studies of the Processes of Electrification of Clouds Measurement of the Electric Field Potential Gradient and the Conductivity of Air on "Disturbed Days"

The characteristic changes of the electric field potential gradient during the development of cloudiness (8) and in stormy periods (9) were studied.

Changes in the electric characteristics of clouds under the influence of an active reaction were studied (10).

Studies of the change in conductivity, ionic spectrum and current in the atmosphere under various meteorological conditions have been made (5,11,12,13,14).

C. Study of Storm Activity

A study was made of the processes of formation and development of lightening electricity (15, 16, 17, 18, 19, 20) and of lightening (21, 22); safety of flights in storm clouds was studied (23).

D. Study of the Mechanisms of Electrification of Separate Particles

Theoretical and experimental studies of the mechanism of the electrification of cloud and precipitation particles under field (24, 25) and under laboratory conditions (26, 27, 28, 29) were made, and experimental data on electrical charges of particles of clouds (30) and of precipitations (31) was obtained. The role of electric charges in the coagulation of drops was noted.

E. Development of Methods and Apparatus

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A whole series of methods for studying the elements of atmospheric electricity under land and aircraft conditions has been proposed and tested (33, 34, 35, 36, 37, 38).

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2. Auroras Polaris and the Luminescence of the Nocturnal Sky

Work in the field of aeronomy has been done in a number of scientific institutions of the USSR. A brief exposition of the results is given below.

In the Soviet Union during the IGY a multiple network of stations was functioning provided with several dozen wide-angle 180° automatic cameras (Lebedinskiy's system). The technical data of these cameras were already reported in previous accounts. The direction of this work was concentrated in the Moscow State University and scientific-research Institute of terrestrial magnetism, the ionosphere and the diffusion of radio waves. Data obtained using wideangle cameras is presently at the processing stage.

During the IGY, at the Institute of Atmospheric Physics of the USSR Academy of Sciences, spectrographic, photometric and radio location studies of radiation of the nocturnal sky and of auroras polars were conducted. Three stations were created for this purpose: near Murmansk in Loparskaya ($\Phi = 63°37$, $\Lambda = 126°42$), near Leningrad in Roshchino ($\Phi + = 56°35$ $\Lambda = 116°46$) and near Moscow near Zvenigorod ($\Phi = 51°03$ $\Lambda = 120°16$).

In order to make spectroscopic studies spectrographs SP-47, SP-48, SP-49 and SP-50 described in (1) were used. In addition there were at our disposal the spectrographs manufactured at the Institute of Atmospheric Physics of the USSR Academy of Sciences. For work in the infra-red field of the spectrum electronic-optical converters were utilized. Especially good results were obtained using photo-contact tube (2). For photometric studies photoelectric photometers with interferometer light filters with a transmission band of around 100Å. In observing emissions of the nocturnal sky the readings of the galvanometer were recorded by hand. When studying the auroras polaris an automatic recording was made of the data using multi-circuit oscillographs. To determine the temperature of the upper atmosphere along the width of the circuit [kontur] of emissions both in the visible and in the infra-red region of the spectrum, Fabri-Pero interferometers were used. In these interferometers semi-transparent di-electric coverings were used as reflectors of surfaces.

In Lopareskaya, in order to estimate the absorption in the ionosphere during auroras polaris, the intensivity of cosmic noises at a frequency of 31 mc was recorded. At stations in Loparskaya and Roshchino observations were also carried out for radiolocation reflections from auroras polaris. Similar work was done at a number of points in the Arctic. For this purpose radars were used on 70 mc with a pulse power of around 75 kw with antennas of the "wave duct" type. They had azimuth coverage. Besides these, a radar on 30 mc with a pulse power of around 100 kw and with a di-pole antenna at a height of 3/2 of the length of the wave from the earth's surface was working in Loparskaya.

First of all we must note the utilization of the technique of recording weak emissions of the nocturnal sky from ultraviolet to the near infrared field. Now emissions of the hydroxyl around 5300 Å, are freely recorded i.e. even its 6-0 and 9-2 bands are recorded. Using electronic-optical converters in the infrared field emissions are observed of the hydroxyl down to 11000 - 12000 Å with resolving power attaining 2 Å.

On the basis of IGY data N. N. Shefov (3, 4) has presently determined with certainty the intensivity of all bands of the hydroxyl recorded at stations near Zvenigorod in visible and near infrared fields of the spectrum. Extreme values of intensivity of emissions of the hydroxyl are changed within one series. The probability of transfers from one level to lower lying ones agrees much better with Shklovskiy's calculation based on Shol'ts formula, taking into consideration the linear member of the dipolar moment, than with the calculations of Khips and Gertsberg which take into consideration in addition its quadratic member. Of exceptional interest is the dependence of the rotatory temperature of the hydroxyl on the latitude of the observation point. Thus, from observations in Byurakan made by N. I. Fedorova before the beginning of the IGY (5) ($\varphi = 40^{\circ}21$) the rotatory temperature of the hydroxyl had a value close to 200°K whereas in Loparskaya ($\varphi = 68^{\circ}38$) it is usually around 300°K. Such a latitudinal dependence had already been discovered earlier by Chamberlain and Oliver. However the difference of the rotatory temperature of the hydroxyl in northern latitudes at various zenith distances is specially interesting. For example, both at Roshchino and at Loparskaya the rotatory temperature of the hydroxyl is higher at the northern horizon than at the zenith (6, 7). At Loparskaya cases were observed when the temperature of the hydrocycle near the northern horizon exceeded by 50° that which corresponded to the zenith. It must also be noted that at each point of the observations, from day to day, and sometimes even during the night, substantial changes of the rotatory temperature of the hydroxyl by many dozens of °K are observed.

The narrow line of hydrogen Hα are regularly recorded. According to estimates made by V. S. Prokudina (8) and N. N. Shefov (3), its intensivity is estimated on an average by dozens of relays. In such cases, when the spectrograph is directed on the region outside of the Milky Way, the intensivity of this emission clearly corresponds to the intensivity of the hydroxyl emission. This circumstance is exceptionally interesting.

The correlation between intensivities of the forbidden emission of oxygen λ 6300 Å, the emission of sodium λ 5890-5896 Å and the hydroxyl emission is also very interesting. Such a correlation had already been discovered by Barbier and has now been confirmed by V. S. Prokudina (9). The correlation between the sodium and hydroxyl emissions ordinarily were not subject to doubt. But the correlation of these emissions with the emission of oxygen 6300 Å always evoked doubts as a result of the great difference in altitude of the radiating layers, and was usually explained by the blending [blendirovanie] of neighboring emissions using rough electrophotometric measurements with wide filters. In the studies described the blending was removed inasmuch as high quality photographs of the spectrums with good dispersion and high resolving power were used. It is important to note that the electrophotometric studies with interferometer filters which allow the spectral portion to pass through with a width of around 100 Å, do not allow us to establish the correlations indicated above for certain to the same extent. This evidently can be explained by an insufficiently accurate calculation for the blending of the indicated emissions by a very intensive emission continuum.

Besides the atomic lines and the molecular bands in the whole region of the spectrum admissible to us the continuous emission continuum is photographed with confidence. It has been studied N. N. Shefov (3, 4). Its maximum intensivity is around 6000 Å. The distribution of energy suggests a continuum connected with the luminescence arising during the reaction of nitric oxide with atomic oxygen. The intensivity of the continuum changes from day to day. In the region of its maximum intensity it oscillates from one tenth to several relays per angstrem. It has not been ruled out that the intensivity of the continuum diminishes after strong magnetic storms and auroras polaris.

The reciprocal blending of various emissions of the upper atmosphere evidently introduces substantial errors into some studies of them which have been made with filters. Thus, for example, American researchers determined the altitude of luminescence of individual emissions of the upper layers of the atmosphere using electrophotometers installed in rockets. It has been shown that emissions of the hydroxyl and continuum passed through the light filters utilized in addition to the expected ones. Hence in the interpretation of data from rocket measurements of the altitude of the radiating layers (16) it is necessary to observe caution. This is accurate and with respect to measurements of the emission continuum is around λ 53000 Å, since in this region we may not disregard the intensivity of the hydroxyl emission.

In Loparskaya T. M. Mulyarchik (10-13) determined the width of the circuits [contours] of the forbidden emission lines of oxygen as λ 5577 and 6300 Å using a Fabri-Pero interferometer. On a night during which there was no aurora polaris, a temperature of around 300°K was obtained on a green oxygen line. A difference with a temperature of around 200°K, which was obtained earlier by a similar method over lower latitudes, exceeds the errors of the measurements. Evidently both the size of the rotatory temperature of the hydroxyl and the increase in width of the green line of the oxygen, with the transfer to higher latitudinal regions, testifies to the increase in temperature of the upper atmosphere from the equator to the poles. The temperature after changes in the red oxygen line turned out to be close to 1200°K which is also higher than the temperature obtained by a similar method by other authors at lower latitudes. The temperature measured in a red oxygen emission in a crepuscular flash was approximately 300°K lower than the temperature in the same emission at night time. This evidently indicates that the crepuscular flash of the red oxygen emission originates in the lower layers than does its radiation at night.

During the absence of aurora polaris we are successful in positively recording the narrow Hα emission. Quite frequently in Loparskaya which is located on the southern border of the zone of auroras polaris, and less often at more southerly stations, the expanded Hα emission with a clearly expressed doppler shift to the shortwave region is recorded in addition to the narrow Hα line, if the radiation comes from the direction of the magnetic zenith. Studies of the hydrogen emission of auroras polaris have been completed at Loparskaya by Yu. I. Gal'perin (14-18). Usually the maximum of the emission in the magnetic zenith is shifted relative to the narrow line for a distance corresponding to the speed of motion of the hydrogen atoms being radiated towards the Earth at around 300-400 kilometers per second. The expanded hydrogen emission is traced in the short wave region down to distances corresponding to speeds of 1.5 - 2 thousand kilometers per second. From the red side relative to the unshifted emission Hα this expansion is observed up to distances corresponding to speeds of around 100-200 kilometers per second. The portion of Hα radiation from the red side amounts to around 10-20% of its full size and, evidently, is explained by the superposition of hydrogen radiation dispersed through the lower atmosphere near the magnetic horizon. In Loparskaya an expanded hydrogen emission is observed quite often during an absence of any visible traces of aurora polaris. Cases have been noted when a hydrogen emission with an expanded circuit [kontur] was observed during the absence of aurora polaris even for a whole night long. During the appearance of such a hydrogen emission without aurora polaris quite often no substantial magnetic disturbances were recorded. However, usually 2-3 hours after the appearance of the hydrogen emission aurora polaris develops and intensive geomagnetic disturbances begin. In Loparskaya a hydrogen emission practically speaking is observed during all auroras polaris at any stages of their development. When we do not succeed in detecting a hydrogen emission in auroras polaris, we often still may not state that it is absent, since in its place will appear other more powerful blending emission. The hydrogen emission, evidently, does not have a noticeably expressed correlation with the intensivity of the principal emissions of the aurora polaris, if we do not consider a certain tendency which expresses itself in the fact that in all intensive auroras polaris an intensive hydrogen emission is present. An exceptionally interesting circumstance lies in the fact that the circuit [kontur] of the hydrogen emission within the limits of accuracy of the measurements is kept constant at any stages of development of the aurora polaris and does not depend on the geomagnetic latitude of the place of observation. As was already noted earlier, the regions radiating a hydrogen emission shift in a southerly direction during the evening hours on an average. This is completed approximately before midnight; then towards morning as a rule the return movement is observed (14, 17, 18). According to data of F. K. Shuyskaya (19) the Bal'merovskiy decrement of attenuation of the hydrogen emission for $H_\alpha : H_\beta : H_\gamma$ can be represented as 3 : 1 : 0.8, respectively.

The intensivity of the hydrogen emission does not correlate with the intensivity of the most characteristic emissions of the auroras polaris. This indicates that the disturbance of the principal portion of these emissions is not connected with the rapid protons invading the atmosphere.

The effect of the reaction of the corpuscles on the atmosphere can be detected also by the increase in absorption of radio waves (20). With the invasion of protons there arises an emission of L_α hydrogen which increases ionization in the absorbing region of the ionosphere below 100-120 kilometers and which does not penetrate to the earth's surface. Rapid electrons can exert a similar effect either during their direct penetration into these regions or by means of X-rays which appear during the bombardment by them of the lower parts of the atmosphere.

Besides recording the intensivity of the wide hydrogen emission H_α, B. P. Potapov, Z. Ts. Rappoport and T. B. Barsuk (21) made observations in Loparskaya of the absorption of a cosmic radio emission on a frequency of 31 mc. Simultaneously absorption was measured using an ionosphere station on a frequency of 2.2 mc by the impulse method. In both cases an increase in the absorption of radio waves was noted during auroras polaris. Ordinarily it began during the emergence of a visible luminescence in the north, when it was not yet possible to observe any luminescence near the zenith. Red luminescences of type A which appear at great altitudes were usually not accompanied by considerable absorption. Strong absorption appeared during greenish-yellow radiated forms, especially when the corona arose in the zenith. Moreover, it is very interesting to note that the maximum of absorption usually lagged behind relative to the flash of luminescence by several minutes. In some cases a considerable increase in the absorption of cosmic noises without a noticeable absorption in the D layer was noted. This was established by means of a comparison of the rate of absorption of cosmic noises with the absorption of the lower region of the ionosphere which is determined by pulse sounding using a ionosphere station on a frequency of 2.2 mc. We may assume that in this case the increase in absorption was connected with the high F60 ionization in the E or F regions of the ionosphere. A comparison of cases of increase in absorption of radio waves with the appearance of the expanded hydrogen emission $H\alpha$ shows that when this emission is present a somewhat increased absorption is always observed. However, under these conditions we cannot succeed in establishing any positive correlation between the absorption and intensivity of the $H\alpha$ emission near the zenith.

Thus data concerning the absorption of radio waves show that it evidently appears both at the expense of the rapid protons and at the expense of the rapid electrons. However, since the most intensive absorption arises during the moving, clearly expressed radiated forms of the aurora polaris, at which time the intensive broad $H\alpha$ emission is observed least, then we can assume that the rapid electrons invading the atmosphere are the most effective source of ionization below 100-120 kilometers.

During an intensive aurora polaris, on the night of 10 to 11 February 1958, at the station near Zvenigorod A. V. Mironov, V. S. Prokudina and N. N. Shefov (22) recorded the sharp increase in intensivity of emission of 10830 Å. In this region of the spectrum of radiation of the nocturnal sky the intensive wide Q - branch of the band of the 8-3 hydroxyl is always recorded. However, on the night of this aurora polaris the emission of λ10830 Å was many times more intensive than the Q - branch emission. This is positively established on the basis of the intensivity of neighboring R and P - branches of the same band. Neither before nor after this was such an intensification recorder during the photographing of spectrums of the nocturnal skies in the northern part of the sky. It is completely natural therefore to ascribe a supplementary step to the Q - branch for the emission of around 10830 Å of a certain emission of helium with a similar length of wave. During other auroras polaris it was not possible to record such an emission.

Inspection of many moving picture film of auroras polaris involving repeated projection shows quite convincingly the macroscopic movements of large formations (23). More exactly these movements and changes were

traced by visual means, and the separate stages of development of the "patterns" were photographed by ordinary cameras. In a number of cases, particularly when a not especially extensive aurora polaris of local importance was observed, it was possible to observe, how an arc or band, shifting from west to east, gradually gained in clarity, acquiring a radiated structure and then shifting along a spiral with a gradually increasing radius (20). Sometimes luminous spots were observed from which one or two sleeves issued, also developing along a spiral. Their photographs very much suggest a image of spiral galactics. Formations were also observed in which the eastern and western parts were bent in one direction. Sometimes similar formations were observed which in the
course of an hour and even more preserved some sort of definite geo- F
graphical position. In a number of cases, after the extinguishment of 6
an aurora polaris, after a certain time amounting to even an hour, there 0
again appeared auroras polaris at the very same place with a pattern similar to the one which had disappeared.

The discovery of another very strange form of aurora polaris is also very interesting (23). This is generally diffuse, a formation of incorrect form, with a comparatively slowly changing pattern and intensivity, characterized by the fact that waves of extinguishment run through it periodically for a period of several seconds or for several tenths of seconds; moreover, after their passage the pattern and intensivity of luminescence are re-established in their original form.

Data concerning kinetic temperature in the region of auroras polaris are very interesting and were obtained by T. M. Mulyarchik (10-13) from contours of various emissions using a Fabri-Pero interferometer. It has been established that in red luminescences of type A appearing at a great altitude, for example, in red spots, the temperature determined on the basis of the forbidden emission of oxygen of 6300 Å, increases approximately from 1000° to 3000° with the growth in intensivity of this emission from several kilorelays to one hundred kilorelays. The temperature determined on the basis of the forbidden emission of nitrogen of around $\lambda 5200$ Å is approximately equal to 2000° K. The ratio of intensivities of the components of the doublet of this emission $I \lambda 5200$ Å turned out to be equal to 1.7. The temperature of the upper atmosphere, measured along the width of the forbidden emission of oxygen of 5577 Å fluctuates from 160°K in the case of bright radiated forms to 250°K in diffuse and homogeneous forms of luminescence. At the time of bright pulsating forms a temperature of $\sim 350^{\circ}$K has been recorded. This emission arises principally at lower levels of atmosphere than the red emission. Thus, the temperature of the upper atmosphere during auroras polaris, especially at great altitudes, increases considerably (24).

The results of a study of the distribution of intensity of the luminescence of the aurora polaris in the firmament, made by N. V. Dzhordzhio (25) were very interesting. A considerable part of the energy of activation of the aurora polaris, as it turned out, was not at all concentrated in the brightest formations, arcs, and bands both of a homogeneous and of a radiated structure.

Auroras polaris in which the predominant portion of radiation is radiated in these brightest formations are seldom observed. In the majority of cases the total flux of energy given off outside these formations in the weaker diffuse background surrounding them exceeds several times the total flux of energy given off in bright sharply defined forms.

As a result of analysis of a large number of photographs of the spectrums of auroras polaris obtained at all our stations, it was established by Yu. I. Gal'perin (17, 23) that these spectrums can be placed between two extreme types. One of them is characterized by an increased relative intensivity of atomic emissions of oxygen and nitrogen. It is usually peculiar to the aurora polaris ot low latitudes and can be called a red, high type of aurora polaris. Another extreme is the greenish-yellow type which is best characterized by the presence of bands of molecular nitrogen and oxygen. The hydrogen emission is frequently accompanied by the aurora polaris of the first type which have atomic spectrums. Several spectrums of auroras polaris were obtained when the meridional section of the arc was designed for the aperture of the spectrograph. The altitudinal distribution of intensivity of the hydrogen emission in several instances sharply fails to coincide with a similar distribution of intensivity of other emissions, although an approximately identical rate of intensivity is met with. With a different rate of change in intensity with altitude the maximum hydrogen emission is above the maximum for other emissions. In the majority of cases the location of the hydrogen emission in the firmament is loosely connected with the sharp pattern being formed by other emissions, particularly with the finely structural radiated forms. This is explained by the fact that the protons have a large effective cross section of overcharging, as a result of which, being converted into neutral atoms they are scattered in the atmosphere considerably more than the concentrated beams of hard electrons.

N. N. Shefov, F. K. Shuyskaya, N. V. Dzhordzhio, V. S. Prokudina and A. V. Mironov (23-30) have established interesting correlations between emission of auroras polaris. Their results are enumerated briefly below.

In the majority of cases emissions of oxygen 01 (λ6046 and 6158 Å) correlate with emission of nitrogen N I (6482 Å) and N II (5680 Å). Rapid electrophotometric recording simultaneously using several electrophotometers confirms the strict correlation between emissions (01) 5577 Å and $IN_2N_2^+$. However, it has been noted that sometimes the intensity of the red emission (01) 6300 Å is found to be in antiphase with these emissions. The ratio of the intensities of forbidden oxygen emissions of oxygen λ 5577 and 6300 Å depends on the intensity of luminosity. The 5577 Å emission predominates below. This variation of the ratio of intensities is especially sharply expressed in the radiated forms of auroras polaris. The maximum ratio of intensities of the 5577 Å emission to the 6300 Å emission is approximately equaly to 100, and the minimum is $\sim$ 0.1. Since the greatest ratio corresponds to the brighter formations of the aurora polaris, it indicates the intensive extinguishing of the activated state of ^1D oxygen in the bright forms of auroras polaris. Comparison of population densities of fluctuating levels of the state $C^3\Pi_u - N_2$ obtained at stations at various latitudes, shows that the fluctuating temperature of this state of N_2 is connected with the type of spectrum of the aurora polaris and is greatest in the greenish-yellow luminescences of high latitudes.

Observations near Loparskaya and Zvenigorod confirm that a clear correlation exists between the forbidden emissions of atomic oxygen of 6300 Å and of atomic nitrogen of 5200 Å. The intensity of these emissions, in their turn, reveals some correlation with the magnetic K - index. At the lower latitude station near Zvenigorod the expanded hydrogen emission was not recorded before the beginning of the aurora polaris. However, a sharp increase in intensity of the emissions of λ6300 and 5200 Å were quite often observed here. The nitrogen emission of 5200 Å was often observed even in the absence of a visually observed aurora polaris. Its intensity was estimated at ten relays.

Results of a study of the records of rapid variations of the intensities of various emissions in pulsating forms of auroras polaris, obtained by N. V. Dzhordzhio (25, 29) are very interesting. Sinusoidal pulsations were observed with a frequency of fractions of a hertz (cycle per second) to several hertz. The changes in intensity are cophased for allowed emission, while the forbidden emission of oxygen of 5577 Å remains several tenths of a second behind them in phase; moreover, at this time no changes in the intensity of the forbidden emission of oxygen of 6300 Å were observed.

A change in the type of auroras polaris from high altitude to low, greenish-yellow and the reverse in the time being measured even in several seconds has been recorded visually and with the aid of an electrophotometer. (23, 29). This circumstance indicates that the speeds of the corpuscles penetrating the atmosphere change for such short intervals of time. Therefore they cannot reflect the original speeds of the solar corpuscles. Evidently the particles causing the phenomena of auroras polaris either are generated near the Earth or the solar corpuscles change their original speeds there.

Simultaneously with the optical studies Ya. G. Birfeld, A. I. Grachev, V. I. Pogprelov, V. I. Yárin, F. E. Martvel' (31-38) carried out observations of radar reflections from auroras polaris. Since the diagram of the directivity of the radar antennas included angles in tenths of degrees, a clear correspondence between the regions reflecting the radio waves and the luminous formations could not be established. The considerable distortion of the trajectories of radio wave diffusion in the heteorgenous ionosphere during the aurora polaris evidently hindered this to a considerable degree. Evidently, the radar reflections from auroras polaris are most probable only when the direction of the diffusion of the sounding impulse is perpendicular to the magnetic power line in the place of reflection. Usually the reflections were observed from region E at a distance of many hundreds of kilometers from the radars. At the present time there has been established only a statistical correlation between auroras polaris and the radar reflections from them. At night, in the absence of auroras polaris, there were practically no radar reflections. Both these phenomena clearly correlated with magnetic activity. Observations of radar reflections from auroras polaris seemed valuable because they could be carried out under any meteorological conditions. It was expected also that with their help it would be possible to detect auroras polaris in the day time, when optical observations of them are absolutely impossible. However the result of the observations turned out to be quite unexpected. In the day time no intensive radar reflections were recorded. At this time very weak reflected signals, distinct in character from the nocturnal ones were observed now and then. Night radar reflections are usually characterized by their variability and changing distance of reflection. Day time reflections although weak are calmer and are situated at a smaller distance interval.

At the Arctic Institute a series of projects on the study of auroras polaris have been carried out.

A. I. Ol' (39) studied the dependence of the form of an 11-year cyclic curve of a number of auroras polaris in Scandanavia on the phase of a 90-year cycle of solar activity. It has been found that with the 11-year cycles taking place near the maximums of the 90-year cycle, the form of the cyclic curve is anomalous - luminescences are observed most of all not in the maximum of 11-year cycles of solar activity, but near the minimums, whereas with other cycles the mean cyclic curves of a number of auroras polaris and of relative numbers of solar spots are very similar to each other. The assumption has been made that the anomalous increase of the number of luminescences in the minimum of some 11-year cycles arises as a result of the increase in the number of red auroras polaris of type B in these periods. The conclusion has been drawn from this that solar corpuscular radiation in these periods has on an average higher energy.

Ya. I. Feldstin (40) studied hourly visual observations of auroras polaris of 50 polar stations for the period from October 1954 to March 1955. Charts of isochasms [izokhazm] were constructed separately for magnetic-calm and magnetic-stormy days. It was shown that on magnetic-stormy days the southern border of the zone of maximum auroras polaris is located 2° more southerly than on magnetic-calm days, and the northern border - 1° northerly.

On magnetic-stormy days of luminescence in the zone they appear almost twice as often as on magnetic-calm days. It has also been shown that in the near-polar zone the daily rate of frequency of appearance of the luminescences is slightly expressed and the luminescences appear equally seldom both in the morning and nocturnal hours. Proceeding from the presence in the latitudinal distribution for the morning hours of the second maximum of frequency of auroras polaris the assumption is made that at the geomagnetic latitude of the order of $\Phi = 78^{\circ}$ a second zone of auroras polaris exists.

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The Scientific-Research Institute of Terrestrial Magnetism of the Ionosphere and the Distribution of Radio Waves also executed a number of projects on auroras polaris.

G. O. Frishman published the principal results of electrophotometric measurements of absolute magnitudes of brithnesses of the strongest components of radiation of the spectrum of auroras polaris in the region of 3900 - 8700 Å, made at Murmansk for the period from 1954 to 1957 (41). On the basis of these measurements the distribution of energy in the spectrums of auroras polaris of different forms in the given region was obtained. All results of measurements of absolute brightnesses are corrected for absorption in the earth's atmosphere. A difference has been detected in the distribution of energy in the spectrums of diffuse and radiated forms. The intensities of bands of 3914 and 4278 Å appear to be higher than the intensity of the green line. Greater variations take place in the distribution of energy in the spectrum in the red and infrared regions.

L. S. Evlashin reported the preliminary results of a study of auroras polaris in Murmansk on a spectral camera C-180-S (F=1.5, dispersion 260 Å) mm/ during 1957-1958 (42).

The space-time variations of the principal emissions of auroras polaris and twilights were studied. The presence was detected of hydrogen lines H α and H β in non-radiated calm arcs, diffuse bands, spots and a scarcely noticeable fuzziness.

With the transition to radiated forms the hydrogen radiation disappears; sometimes it is observed in the "afterglow". In red luminescences the hydrogen radiation is not recorded. The results of a recording of Hα on the camera were controlled by a SP-48 spectrograph with a high resolving power.

L. S. Evlashin analyzed more than 7000 spectrums of auroras polaris obtained at Murmansk on a C-180-S camera during 1957-1959. The hydrogen radiation was recorded over a period of 96 nights. Variations in intensity of the hydrogen lines testifies to the different mechanisms of the activated spectrums of diffuse and radiated forms of auroras polaris. It has been noticed that the zone of simultaneous invasion of protons can be not less than 2000 km in latitude. Rapid displacement of the region of the hydrogen emission from north to south and back (sometimes for a 10-15 min. period) is not accompanied by disturbances of the geomagnetic field.

Hydrogen lines are observed when the magnetic field is in a calm state. In all probability the invasion of protons is not the direct cause of disturbance of the geomagnetic field.

A study of emissions of the nocturnal sky and auroras polaris was also made at the Abastumanskaya observatory. T. G. Megrelishvili detected the emission of lithium and possibly a number of other emissions in twilight radiation (44). L. M. Fishkova and G. V. Markova carried out electrophotometric observations of an intensive low-latitude aurora polaris on 11-12 February 1958 (46). They regularly recorded the narrow emission of hydrogen Hα in the nocturnal sky (47). L. M. Fishkova perfected the control of the transparency of the atmosphere through measurements of the brightness of the Polar star. (48). She herself together with G. V. Markova processed electrophotometric observations of many years of emissions of the nocturnal sky at Abastumanskaya observatory (49). In the Murmansk department of IZMIRAN I. G. Frishman developed a spectrometer for recording the basic emissions of auroras polaris (51). The spectrometer is built on the basis of a monochronometer with a diffraction lattice with dimensions 70 x 80, 600 strokes.mm [shtr/mm], working in the second order. In the green region of the spectrum the monochronometer has a dispersion of 11.4 Å/mm. Radiation receiver is FEU-19-M, its sensitivity of 4278 Å equals 1.1 x 10^6 A/watt. The photoelectric current of the FEU becomes stronger by means of the resonance amplifier, tuned to a frequency of 238 mc. The amplification factor of the amplifier in the current is 1.3 x 10^7. Photographs are given of a recording of spectrums with emissions of 5577, 4861, 4709, 4728, 3914 Å. The same author described an electrophotometer (52), designed for photoelectric studies of the brightness of auroras polaris in the most intensive lines and bands of the spectrum which are being separated by interference light filters. The device permits us to measure up to 10 spectral intervals a second and is designed to record the results obtained on the loop oscillograph. The photometer is calibrated in absolute units. The sensitivity of the photometer is sufficient to measure the brightness of the nocturnal sky. The accuracy of the photometric process for emissions of auroras polaris is estimated at 5%.

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3. Ionosphere

A. Observations.

In connection with conducting the IGY-IGS [ymposium] in the Soviet Union in 1957-1959, the network of permanently active ionospheric stations was expanded (see table) and expedition studies in the Antarctic were organized on floating ice floes and on the schooner "Zarya".

The majority of the stations which were active earlier and are again open is equipped with new ionosounds of the AIS type, developed by the co-workers of the IZMIRAN of the USSR, K. N. Vasil'ev, G. N. Vasil'ev and L. P. Goncharov. Besides vertical sounding of the ionosphere with the start of the IGY at a number of points there were begun regular measurements of winds in the ionosphere, absorption, atmospheric disturbances and whistler atmospherics (see also table 1). The apparatus for measuring winds and absorption is as a rule of laboratory type manufactured on the spot. The standard apparatus for recording the intensity of the field of atmospheric disturbances was developed at the IZMIRAN by Ya. I. Likhter.

The results of all observations carried out under the IGY program are regularly transmitted to the Center for the preservation of V 2 data for international exchange. Monthly summaries of data from observations of vertical sounding are published in the periodical bulletin "Obzor kosmicheskikh dannykh" [Survey of Cosmic Data].

On the basis of experimental data obtained during the IGY-IGS and in previous years, studies are being conducted at the IZMIRAN of the USSR, AANII, Tomsk, Rostov, Moscow and Gor'kiy universities, at the Kharkov and Tomsk Politechnic Institutes and at a number of geophysical observatories and stations along the following lines: morphology and physics of the calm and disturbed ionosphere, theory and practice of ionospheric diffusion of radio waves, electromagnetic radiation of lightening discharges. A number of projects is devoted to the development of new methods of study and to the designing of new apparatus.

Table 4

(a). IONOSPHERE

	Station	Geographic Coordinates Lati-tude	Geographic Coordinates Longi-tude	VI	A	N	W	at	D
1	2	3	4	5	6	7	8	9	10
A001	Arktika 1 (float.)			x					
A003	Arktika II (float.)			x					
A009	Tikhaya Bay (Kheysa Island)	80°37	58°03	x					
A033	Dikson Island	73 32	80 42	x	x			x	
A037	Tiksi Bay	71 33	128 54		x				
A050	Murmansk	68 58	33 05	x		x			
	Salekhard	66 32	66 32	x					
A098	Provedeniya Bay	64 23	173 18	x					
A124	Yakutsk	62 03	129 40	x					
B002	Leningrad	59 57	30 42	x		x		x	
B019	Sverdlovsk	56 44	61 04	x		x			
B022	Tomsk	56 28	84 58	x	x	x			
B025	Gor'kiy	56 09	44 17	x					
B035	Krasnaya Pakhra	55 28	37 19	x	x	x	x	x	x
C003	Chita	52 03	113 29	x					
	Kiev	50 27	30 30			x			
B141	Khar'kov	49 56	36 17						x
	Khabarovsk	48 31	135 07			x			
1013	Rostov-on-Don	47 30	41 30	x	x				
C016	Yuzhno-Sakhalinsk	46 55	142 44	x					
C050	Alma-Ata	43 15	76 55	x	x	x			
	Tbilisi	41 43	44 49			x			
C126	Ashkhabad	33 56	58 22	x	x	x			
A006	Vostok	72 08	96 35	x					
A978	Mirnyy	66 38	92 55	x	x				

VI - vertical sounding
A - absorption
D - winds in the ionosphere
N - atmospheric disturbances
W - whistling atmospherics
at - wave forms of atmospherics

In 1957-1959 IZMIRAN continued work carried out earlier by it on the handling of the radio communications of various departments by means of short-term and long-term prognoses of working frequencies. The long-term prognoses are published in the form of regular monthly and annual publications. The short-term ones are disseminated by telephone, telegraph and are relayed by radio.

B. Principal Results of Scientific Studies.

1) Studies of the Atmosphere using Artificial Satellites.

In a number of projects of Ya. L. Al'pert and others (1-4) a study was made of the outer ionosphere from data from Soviet artificial satellites.

A description is given of the method of study from observations of the moments of "radiorising" and "radiosetting" of the satellite. Results are given of theoretical calculations of maximum horizontal distance for receiving signals. The calculations are made for a spherical Earth; tabulation of the obtained interval of the elliptical type was done using a fast-acting electronic calculating machine BESM of the Academy of Sciences of the USSR. The parabolic model of the lower ionosphere and the exponential reduction of the electron concentration in the outer part of it were used in the calculations.

The parameters of the lower ionosphere, the height of the satellite, as well as the maximum distance for receiving its signals according to observations of the network of ionospheric stations, according to ballistic data and other studies of the true trajectories of the flight of the satellite were used for processing experimental data.

It was learned that the electron concentration of the ionosphere N higher than its maximum N_m decreases considerably more slowly than it increases up to a height N_m. For model $N(Z) \approx N_m e^{-8z}$ the value $\chi \approx 3.5 \cdot 10^{-3}$ km. This makes the number of electrons in the outer part of the ionosphere approximately 3.6 times larger than in the lower part of it. Extrapolation of the data obtained from observations for heights $Z = 300 \div 650 - 700$ km up to $Z \approx 3000$ km shows that when $Z = 2000 - 3000$ km, $N = 200\text{-}300$ el/cm^3. In the lifteime of the electron and the time between the various events of ionization a density curve of the neutral particles n (Z) was constructed. The value is $n \approx 1$ cm^3 at these same heights. The assumption is made therefore that the height of the atmosphere's "frontier", i.e. region, where it is, evidently is adjacent to the interplanetary gas, of the order of 2000 - 3000 km.

L. P. Kurperov (4) analyzed observations of radio signals of the Third Soviet Artificial Earth Satellite at Cape Chelyuskin from 16 May - 6 June 1958. A peculiarity of the obtained results is the fact that they relate to the diffusion of radio signals of the satellite in a completely illuminated atmosphere on a line Satellite - Cape Chelyuskin. The probability has been calculated of detecting radio signals when the satellite is at various distances and azimuths and a table of the magnitude of intensity of the field of the radio station in relation to the location of the satellite higher or lower than the F2 layer within the limits and outside the zone of direct visibility.

2) Vertical Distribution of Electron Density in the Ionosphere from Vertical Sounding Data.

The works of B. S. Shapiro (6, 7) are devoted to the study of time and space variations of true and active altitudes of the ionosphere and to problems of forecasting foemetric parameters and h'f - curves of the ionosphere. Two other works (8, 9) are devoted to an examination of some preliminary results of a study of the geographic distribution of true altitudes of the F region of the ionosphere on the basis of data for October 1957.

3) The Morphology of the F2 Layer of the Ionosphere.

a) T. S. Kerblay worked on the construction of charts of critical frequencies of the F2 layer on cosmic time (10). Two methods are discussed for the construction of f_0F2 charts for the given hours of cosmic time. Appraisals are made of the accuracies achieved using these methods and their superiority over the system of charts for three zones.

b) T. S. Kerblay and E. M. Kovalevskaya studied the correlation of f_0F2 with indices of solar activity (11). In order to study the correlation between f_0F2, the number of solar spots (R) and the intensity of solar radio emission in the decimeter band (ν) coefficients of correlation (ρ) and correlation ratios (η) were calculated and the discrepancies between them were estimated. A systematic positive difference between ρ and η was obtained. The period of high solar activity is characterized not only by a disruption in of linearity of connection but also by a reduction in closeness of connection of any form. During analysis no advantages of ν as an index for f_0F2 were obtained. A study of a reciprocal correlation of f_0F2 for several pairs of stations situated in various parts of the globe has shown that for medium-latitude stations it is possible to attempt to find the mean index for characteristics of mean magnitudes of f_0F2, but it cannot characterize f_0F2 well enough for the whole globe.

4) Variability of Ionospheric Parameters.

N. P. Ben'kova and N. I. Potapova (12) made a statistical analysis of hourly values of critical frequencies and altitudes of the F2 layer of the ionosphere. The detected systematic discrepancies between the distributions of Δf_0F2 (deviations of instantaneous values of parameters from the corresponding median values) and the Gauss distribution of random magnitudes is explained by the incomplete exclusion of disturbance from the data under examination. In conformity with this it was proposed to consider the ionosphere calm when the fluctuations of its parameters strictly obey the law of normal distribution. The magnitude of dispersion (σ), characterizing the variability of the ionospheric parameters, has a daily and seasonal rate and depends on solar activity.

Space distribution of instantaneous values of f_0F2 is quite regular. Simultaneous deviations of ionospheric parameters of one sign and order of magnitude embrace large regions of the ionosphere. In order to study the space distribution of values of f_0F2 coefficients of correlation ρ between simultaneous values of f_0F2 at various stations were calculated. The distance d at which ρ decreases up to 0.5 amounts on an average to 5-7° in latitude, and 20° in longitude. The values depend on the season and the level of solar activity. From a study of the function ρ(d) the inferences concerning the "radius of activity" of the ionosphere station were obtained.

5) Lower Layers of the Ionosphere.

a) M. V. Boenkov (13) studied the daily course of critical frequencies of the E layer of the ionosphere. Formulas available in the literature describing the daily course of the E layer are correct only for the light time of the twenty-four hour period. The author obtained the formula describing the course of f_0 E during a full twenty-four hour period. Comparison of results of calculation according to the formula with experimental data showed satisfactory agreement. An attempt was made to explain the course of ionization of the E layer during morning and evening hours by selective refraction of infrared radiation from the sun.

b) N. P. Ben'kova and M. D. Fligel' examined the results of measurements of absorption in the USSR during the IGY-IGS (14). Magnitudes of the coefficient of ansorption L were compared on the basis of data from Soviet and foreign stations and the dependence of middle-of-the-month values of L on geographic and geomagnetic coordinates was examined. It was shown that the latitudinal distribution L agrees very well with the course Cos 3 (Θ - zenith distance of the Sun) with the exception of high latitudes, where anomalously high values of L are observed. The border of the zone of polar absorption have been established. Annual changes in monthly values of L for a number of stations were examined and it was shown that in the high latitudes there is a correspondence with the annual course of magnetic activity. An inference was made concerning the corpuscular nature of polar absorption.

c) N. P. Ben'kova made a statistical study of the E layer from observations of ionospheric stations of the USSR. (15). The processing of observations for 1946-1953 confirmed the existence of stable seasonal and daily courses of frequency for appearances of the

E_s layer. The daily course in medium latitudes is characterized by the presence of two maximums - during daytime and night hours. Maximums in the seasonal course fall in the summer months. Experimental data available at the present time are insufficient for a final judgement concerning the character of the 11-year cyclicity of the E_s layer. From observations from stations in the Soviet Union it follows that the cyclic changes of a number of E_s correlate badly with the course of solar activity, being not great in amplitude and different at different stations. At high-latitudinal observatories (Tiksi Bay) the amplitude of cyclic oscillations is greater, there being a tendency towards an increase in the number of E_s with a fall in solar activity.

A study of the dimensions of E_s clouds made on the basis of simultaneous observations of E_s at several ionospheric stations showed that E_s clouds are found with dimensions of several hundred kilometers. However, clouds of much smaller dimensions are found more often.

d) N. I. Potapova examined the sporadic E layer on the basis of observations at stations of the Soviet Union during the IGY (16).

The processing of the data for the E_s layer is given, which was carried out in conformity with the classification proposed by the Special Committee for Vertical Sounding. E types most often met at medium latitude stations were isolated. A separation of reflections from the E_s layer with weak and strong ionization was carried out; the daily and seasonal course of the probability of the appearance of E_s of various types for medium-latitude stations was obtained.

The features of the E_s layer at high-latitude stations were examined, as well as its types which are observed during ionospheric disturbances and auroras polaris.

e) V. E. Kashprovskiy proposed a method of impulse-less sounding of low situated layers of the ionosphere. In connection with the absence of special ionospheric stations with a low limit of frequency band, less than 0.5 mc, it is advisable to observe the E layer by comparing a number of radio broadcasting stations working on the 1.0-0.2 mc band and located in a zone of near fading relative to the place of observation. By means of harmonic analysis of the records obtained of the field, frequency components of fading are established and, proceeding from the geometry of multi-jump [mnogoskachkovyy] diffusion, the speeds of the change of altitudes of the reflecting layer, the altitudes of this layer and the presence of heterogeneities in determined sectors of the regions of reflection are determined.

6) Study of Properties of the Lower Ionosphere Based on a Study of the Diffusion of Waves of Low and Ultralow Frequency.

A series of works of Ya. L. Al'pert, S. V. Borodina and D. S. Fligel' (18-24) is devoted to a study of the diffusion of electromagnetic waves of low and ultralow frequency, as well as to problems of harmonic analysis and synthesis of forms of single atmospherics, which permit us to investigate the electromagnetic properties of the lower part of the ionosphere.

Results of theoretical calculations of the spectral function of distribution of these waves in the waveguide of the Earth - the ionosphere, on the basis of which appropriate processing of experimental data is carried out, are described.

A harmonic analysis has been carried out of considerable experimental data which has permitted us to determine the most probable properties of the lower part of the ionosphere causing the transmission of part of the spectrum of waves in the 1000-20000 mc band, comprising a lightening discharge for big distances. Data has been obtained concerning the effective conductivity of the lower part of the ionosphere and the average phase speed of diffusion of these waves.

7) Ionospheric Effects of Solar Eclipses.

N. M. Boenkova (25) has examined the behavior of the ionosphere during solar eclipses on 30 June 1954 and 25 February 1952 at ionospheric stations of the Soviet Union. Calculations were made for values of the effective coefficient of recombination and intensity of ionization of the layers of the ionosphere. On the basis of the ionization-recombination equation, taking into account the chosen value of the effective coefficient of recombination for various layers, the change in intensity of ionization depending on the size of the open area of the Solar disk was calculated. An attempt was made to determine the effect of local Sun formations on various layers of the ionosphere. It has been noted that the ionizing radiation of some layers to a large degree depends on local sources of ionization, while that of others depends on uniform radiation of the Sun.

8) Ionospheric Disturbances and the Ionosphere of High Latitudes.

a) Two articles of G. V. Bukin (26-27) are devoted to ionospheric studies in the Antarctic. The apparatus for vertical sounding of the ionosphere installed at Mirnyy is described and the results of the processing of data for the first year of observations

(1956) are given. The median daily courses of the regular layers and of the E_s layer are described; noted is an interesting feature of the daily course of f_oF1 and the negative correlation of the daily course of E_s with magnetic activity. Typical ionograms are described and illustrated.

Also described is the daily course of ionospheric parameters at Vostok station for March 1958 - the first month of regular work at the station. The characteristics of the apparatus are given.

6) R. A. Zevakina examined the coil-shaped disturbances of the geomagnetic field and the changes in the ionosphere connected with them on the basis of observations at Murmansk (28). Changes in f min, fE_s and f_oF2 during positive and negative coil-shaped disturbances during 1954-1956 are examined. Around 85% were accompanied by anomalous changes in the ionosphere; an increase of fE_s above 3 megahertz and an increase of absorption was observed most often during positive and negative coils. By a change of signs of the H and Z components it has been determined that the center of the currents of coil-shaped disturbances was located north of Murmansk in most cases. With n increase of solar activity the number of coils with centers of currents south of Murmansk grew.

c) R. A. Zevakina examined in the same way the inter connection of ionospheric and magnetic disturbances at high latitudes (29, 30). Anomalous changes in the ionosphere during magnetic storms and coil-shaped disturbances on the basis of observations at Murmansk in 1954-1957 are examined. During storms of all categories and coil-shaped disturbances a significant increase of fE_s and anomalous absorption was most often observed. The character of anomalous phenomena in the course of storms changed with the time of day. Complete absorption was most often observed in the morning hours (4-8 o'clock zone time), increased ($f_{min} > 3$ megahertz) - at noon hours, increased fE_s (> 4 megahertz) - at midnight hours. Positive anomalous Δf_oF2 were observed somewhat more often at night, and negative ones by day. The great correspondence between anomalous changes in the lower ionosphere and magnetic disturbances indicates that at high latitudes processes which develop in the ionosphere during the introduction of corpuscles, chiefly at an altitude of around 100 km, are responsible for magnetic disturbances.

The 27-day recurrence of ionospheric disturbances is quite clearly expressed for the period under review. At the beginning and end of the disturbances the dependence on the time of day is observed, disturbances began most often at 16-24 o'clock, and ended in the period from 0 to 8 o'clock on zone time.

The problem of the utilization of the results obtained for operational maintenance of radio communication at high latitudes.

d) L. N. Lyakhova developed methods for short-term ionospheric forecasting (31-33). The contemporary state of the technique of short-term radio forecasting and the basic propositions on which it is based are examined. In order to explain the possibility of forecasting frequencies for the time of the disturbances the variability of f_0F2 with time and in space was examined. The obtained variability of f_0F2 is close to the variability under calm conditions. Analysis of space variability shows that it is possible to disseminate observation data to an ionosphere station during disturbances only within circumscribed limits of around 10° in latitude and 20° in longitude. Results are given of experimental forecasting for the time of disturbances by means of extrapolation.

e) N. V. Mednikova (34) continued an earlier published (Proceedings of the Corpuscular Cinference, Moscow, 1957, 183-245) statistical study of critical frequencies of the F2 layer during disturbances. Conclusions have been obtained concerning the criterion of disturbance for medium latitudes and concerning the daily course of outbreaks of disturbed periods. The conclusions can be utilized in the practice of short-term radio forecasting.

f) An examination made by A. S. Besprozvannaya of data on ionospheric disturbance in Tiksi Bay has allowed us to establish the daily and seasonal course of ionospheric disturbance and its close correspondence with the state of the magnetic field of the Earth. The presence of a clearly expressed 27-day recurrence of ionospheric disturbance is shown. Deviations of the critical frequency of the F2 layer from the norm are examined and data are given testifying to the presence of positive and negative phases of disturbance.

g) G. N. Gorbushina (36) has analyzed measurements of ionospheric absorption at Tiksi Bay for the period from October 1949 to June 1951. It has been found that during reflection from the F area the absorption in the ionosphere has an inverse dependence on the frequency. For relatively undisturbed conditions in the ionosphere the daily changes of absorption in general outline are similar to those observed at medium latitudes. The polar correction for absorption found as the difference between the measured absorption from all observations (with the exception of cases of complete absence of reflections) and that calculated by A. N. Kazantsev's method, changes in relation to the season and the time of day.

The coefficient of reflection from the E_s layer diminishes with an increase of frequency.

h) On the basis of data from ionospheric observations, carried out on floating ice floes of the 6entral polar basin, data concerning ionization of the upper layers of the atmosphere in the near-polar region were examined by V. M. Driatskiy and A. S. Besprozvannaya (37, 38). A number of important regularities was established both in the course of the regular and anomalous processes in the ionosphere. The results obtained indicate that in a number of cases the generally accepted mechanism of ionization cannot explain the observed effects. In connection with this assumptions have been made for a possible explanation of the peculiarities of ionization in the region of the geographic pole.

i) An examination was made of the nocturnal maximum of the critical frequency of the F2 layer of the ionosphere from observations of the high-latitude ionospheric station at Tiksi Bay (V. A. Lovtsova /39/). For this differentiation twenty-four hour periods with a different daily course of critical frequency are being examined for January and December from 1946 to 1952. A rather close correspondence has been found between the nocturnal maximum and geomagnetic activity. An assumption is made concerning the corpuscular nature of this maximum.

j) V. M. Driatskiy (40) described the collated results of a study of the ionosphere and the diffusion of radio waves in the Soviet Arctic, obtained during the last 15 years. Data are being kept on the regular and anomalous processes in the ionosphere and their connection with the state of the magnetic field of the Earth. The peculiarities of the conditions of the diffusion of short and medium radio waves at high latitudes and problems of radio direction finding and atmospheric disturbances are examined. Outlooks for the development of ionospheric studies are indicated.

k) On the basis of a large complex of geophysical observations during the winter of 1955/56, F. Ya. Zaborshchikov and N. I. Fedyanina studied the connection between auroras polaris, the state of the ionosphere, conditions of radio wave passage and the Earth's magnetic field (41). It was noted that the passage of radio waves with a frequency higher than 24 megahertz for considerable distances was connected with positive magnetic coils and luminescences of calm forms. With negative magnetic coils there were observed originally bright mobile forms of luminescences and afterwards diffuse and pulsing ones.

l) In (42) is described the work of the European-Asiatic regional center for IGY warnings, the functions of which the department of short-term radio forecasting of IZMIRAN used to fulfill.

9) Tidal Movements and Winds in the Ionosphere.

2) A number of works (43-46) is devoted to a study of non-homogeneous structure and movements in the ionosphere. The network of stations is described which carry out observations of drifts under the IGY-IGS program. Results are given of observations of drifts at Soviet stations during 1955-1958. A comparison is given of the results of simultaneous observations for large and small heterogeneities under the IGY program. The regularities of the daily behavior of the size and direction of speed of drift in the ionosphere indicate the existence of a single circulation in the F2 layer for small and large formations. Moreover, cases of remarkable differences are noted. Ideas on the
F possible causes of these discrepancies are given. Recommendations are
6 given on the technique of observation of movements of heterogeneities
0 in the ionosphere.

b) V. A. Zagulyaeva made a study of lunar tidal movements in the ionosphere (47). Calculations are made of lunar tides from data from five ionospheric stations of the Soviet Union located at Ashkhabad, Moscow, Leningrad, Tomsk, and Irkutsk. From data from the Ashkhabad ionospheric station amplitudes and phases were obtained of tidal variations of critical frequencies of the E, F1, F2 layers, as well as of minimal active altitudes of the F2 layer. From data from other stations amplitudes and phases were obtained of tidal variations of critical frequencies of the F2 layer. The results are being examined and assumptions are being made concerning the movement of ionized masses caused by tidal forces.

10) Ionospheric Diffusion of Radio Waves.

a) Ya. L. Al'pert used the idea of the statistical nature of the ionosphere to explain the scattering of radio waves in the ionosphere (48). The results are described of the determination of fluctuations of electron density on the basis of measurements of the "turbidity coefficient" of the ionosphere and of energy scattered by it on ultra-short wave. On the basis of calculated formulas an expression has been stated for the effective scattering cross section obtained for the coefficient of correlation $p(r) \backsim \exp[-(r/\xi)^2]$. The author reaches the conclusion that in the case of vertical sounding of the ionosphere on frequencies below the critical frequency at the observation point, along with a "mirror" reflected wave, waves are also used which have been scattered first and reflected afterwards from higher levels of the ionosphere. But in the case of an inclined and distant diffusion of ultra short waves through the ionosphere scattering on heterogeneities of optimum dimensions plays the biggest role.

B. V. Boenkov (49) examined the diffusion of radio waves having a length of 6-10 m for distances of several thousand kilometers at the expense of reflection from the ionosphere. He has indicated the possibility of forecasting interconnections in these waves. The assumption has been made concerning the possibility of the practical use of waves in the 6-10 m band during the 8-9 year cycle of solar activity.

b) A number of works is devoted to an examination of ionospheric conditions of short wave radio communication at high latitudes. G. N. Egorov (51) has shown how by means of listening to distant short wave radio stations we can compile a forecast of passage conditions and determine working frequencies of a concrete radio link 6 hours ahead of time. Using the example of the Moscow-Tiksi radio link it is shown that the work on recommended frequencies increased the stability of communications by 25%.

L. P. Kuperov (52) studied the peculiarities of conditions of short wave aircraft radio communication in the Arctic in connection with the state of the ionosphere. Experimentally obtained data are given concerning the audibility of aircraft radio stations at various distances. Information is included concerning the peculiarities of communication on medium waves. Charts of isolines have been constructed of identical intensity for the measurements at definite geographic points.

In (50) data are given on rated and used-in-practice frequencies for short wave radio communication for the long distances between Moscow and the Antarctic. Causes are analyzed of the most favorable time of day for reliable communication on similar radio links. Some data on radio communication in the Antarctic region are also examined.

c) At IZMIRAN a forecast of maximum frequencies used for different solar activity was compiled (55). The diagnosis was compiled keeping in mind experimental data on the cosmic network of stations in recent years. It contains charts of critical frequencies and maximum frequencies used (MPCh) of 3000 for low (W=0) and for high (W=100) levels of solar activity and can serve as initial data for designing radio communication links, the solution of various technical problems and the distribution of the frequency band.

d) In these works (53, 54, 56, 57) procedural problems in calculating radio communication are examined. Z. Ts. Rapoport (54) examines a simplified calculation of the coefficient of MPch-M3000 as the well-defined function of the altitude of the maximum of ionization of the layer when there is parabolic approximation - h_p.

For this data were used from the Murmansk Ionospheric station for December 1957 - December 1958. A table is given for M3000 = f(hp). An examination was made of the calculation of monthly values of the coefficient (M3000) F2 using median values of h_p (with the aid of the indicated table). The contrast of the values thus obtained (M3000) F2 with values of M determined using standard curves of diffusion (for the example the odd months of 1958 were taken) does not exceed two percent.

Sh. G. Shlionskiy (55) proposes a means of calculation which allows us to resolve rather simply the complex of problems in the determination of MPCh, the field intensity, the required transmitter
F60 power for any types of communication and technical means. For calculation it is advisable to use physically based and contemporary data concerning the field intensity of the signal and the levels of atmospheric disturbances.

e) A. V. Gurevich examined problems of the effect of the electromagnetic field of radio waves on the properties of ionospheric plasma. In these works (58, 59) it is shown that under the action of a wave falling on the ionosphere the properties of the ionosphere can be substantially changed, namely: its temperature, the effective number of electron collisions, the conductivity and di-electric penetrability of ionospheric plasma. The dependence of the magnitudes on the amplitude of the field, the wave and its frequency has been calculated. On the basis of these works the problem of the diffusion of strong radio waves in the ionosphere has been examined and expressions for the absorption and phase of such radiowaves have been obtained (60). It is shown that under definite conditions waves pass unhindered through the ionosphere.

11) Electromagnetic Radiation of Lightening Discharges.

a) At IZMIRAN Ya. I. Likhter made a study of the statistical properties of the field intensity of atmospheric radio interference. A technique and apparatus for measuring values of functions of the distribution of the field intensity envelope of atmospheric radio disturbances have been developed. The basic element of the apparatus is a ten-channel statistical analyzer by means of which the relative staying time of the envelope above ten levels was measured. The first measurements were made with this apparatus which showed that the field of atmospheric radio disturbances consists of two components: a comparatively weak part obeying the normal law of distribution (Gauss' law) and a more powerful-impulse component.

A comparison was made of various formulas proposed by different authors for approximating experimentally the observed functions of distribution of the field intensity envelope of atmospheric radio disturbances. It was found that on frequencies below 100 kc the formula

$$p(E) = [1+(E/E_{50})^{g}]^{-1}$$

is more accurate and convenient, where E is the median of distribution, and g is the parameter depending on the dynamic band of field fluctuations of atmospheric disturbances (64).

b) V. E. Kashprovskiy examined several properties and the mechanism of the diffusion of atmospherics. For an analysis of processes accompanying lightening discharge, their spectral properties were examined (65). An interpretation was given of the observed processes on oscillograms of electromagnetic disturbances caused by these discharges. An examination was made (66) of the phenomenon of deformation of the shape of the impulse of the atmospheric electromagnetic disturbance (atmospherics), which is explained by the fact that waves of very low frequencies which basically determine the shape of the impulse, are diffused in a natural waveguide formed by the surface of the earth and by the D and E layer of the ionosphere. Diffusion occurs chiefly by means of waves of the TM type; for short ones f = 2.5 kc, while the minimum of absorption lies around f = 5 kc.

c) V. E. Kashprovskiy described (67) the results of work performed on the creation of a radio direction finding system for storms in the USSR, which works at great distances and is adapted to the operational maintenance of the hydrometeorological service. A means of study was also examined which could increase the accuracy and quality of calculations of the locations of lightening flashes.

12) Development of New Apparatus.

At IZMIRAN there were developed and designed 2 units for ionospheric measurements. In (68) is described the single-dial control ionospheric station, manually controlled, with mechanical coupling of tunings of the master oscillator of the transmitter and receiver, intended for vertical sounding of the ionosphere and in particular for measuring absorption and winds in the ionosphere. The frequency range of the station is 0.5 - 16.0 mc, an emission power of 30-50 kilovolts in an impulse with a duration of the order of 100 μ sec. The system of single-dial control tuning permits us to use the transmitter simultaneously in order to emit several frequencies. In (69) is described an apparatus installed at NIZMIR to measure absorption and wind in the ionosphere, consisting of the following basic parts:

1) pulse transmitter with simultaneous emission of circularly polarized waves on the 1-16 mc band, 2) two pulse receivers, 3) control double oscillograph with a system of scans and gating, 4) two recroding double oscillographs with photocameras. The apparatus allows us to carry on the recording of amplitudes of multiple reflections from the ionosphere and from effective heights of layers simultaneously on two frequencies, on the 1-16 mc band, for subsequent determination of absorption.

The recording of amplitudes of reflected signals from three receiving antennas in order to determine the speed and direction of the winds is also done simultaneously on two fixed frequencies. In the apparatus the original transmitter is used, which consists of two smooth heterodynes with pulse modulation on the 22-38 mc band, a quartz heterodyne on 22 mc, a mixer and wide-band and power amplifiers common to both frequencies. Filters for the reception of a circularly polarized wave are included between the pre-final cascades of the amplifiers of power. At the Murmansk department of the IZMIRAN Z. Ts. Rapoport together with B. P. Potapov developed an integrating machine with an anode-grid capacity for the unit in order to measure absorption of radio waves in the ionosphere (70). Its adjustment and peculiarities are described. An example is given of the recording of integrated values by a stylus-writing instrument.

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4. Cosmic Rays (In Their Relation to Geophysics)

In the work on the geophysical aspect of cosmic rays the following organizations participated: Phusics Institute of the USSR Academy of Sciences (FIAN), Moscow State University in the name of Lomonosov (MGU), the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Diffusion of the USSR Academy of Sciences (IZMIRAN), the Yakutsk branch of the Siberian Department of the USSR Academy of Sciences (YaFSOAN), The Arctic and Antarctic Institute GUSMP [Hydrographic Administration of the Glausevmorput], (AANII), the Magnetic Laboratory of the USSR Academy of Sciences, the Crimean Astrophysics Observatory of the USSR Academy of Sciences (KRAO), the Cossack State University.

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At the start of the IGY 7 land stations for cosmic rays were working in the Soviet Union, at which continuous recording was done using 12 instruments (10 standard instruments for ionization chamber ($\mathcal{J}$), a cubic telescope (T) and a neutron monitor (NM) and two non-standard units for underground measurements and for measurements of broad atmospheric downpours in Yakutsk). For the period after September 1957 a station was organized at Murmansk (IZMIRAN) (J, NM) which began recordings of the neutron component in the Antarctic at Mirnyy station (J, NM) (IZMIR); the work of the instruments was fixed at other stations: Kheysa island (T, NM) (ANII), Tiksi bay (J) (YaFSOAN), Irkutsk (J, T, NM) (IZMIRAN), Simferopol' (T) (KrAO), Moscow (NM) (IZMIRAN).

In 1959 11 stations and 22 instruments were working. The program of stratospheric measurements has been increased beyond the station at Dolgoprudnaya and Loparskaya (FIAN) which were working since the beginning of the IGY; stratospheric measurements were organized in the Crimea (FIAN) and at Yakutsk (YaFSOAN).

Measurements of the neutron component were organized on the schooner "Zarya" in order to ascertain precisely the position of the equator of cosmic rays and the study of the latitudinal effect (IZMIRAN).

At IZMIRAN a large project was carried out in the designing of apparatus, the organization of stations, the training of cadres and the perfecting of techniques for correcting meteorological effects. The manual on the processing of data was revised and was duplicated by a rotaprint process. The manual was distributed to foreign scientists to acquaint them with the technique of processing data received in the USSR.

The results of methodological work are given in articles (2-11).

IZMIRAN co-worker L. I. Dorman wrote the monograph "Variations of Cosmic Rays", Moscow Gostekhteorizdat [State Technical-Theoretical Publishing House], 40 pages. The book was written in connection with the preparation for the IGY in the Soviet Union and was published at the beginning of the IGY in June 1957. In February 1958 the book was translated into English and published in the USA under the title L. J. Dorman "Cosmic Ray Variations" Air Force Base, Ohio 1958 (translation from Russian). The translation of the book was distributed by an American publishing firm among researchers of all countries.

In the book experimental and theoretical methods of investigating variations of cosmic rays (temporary changes in their intensity) are given; the experimental material accumulated by the beginning of the IGY has been systematized and analyzed and the hypotheses proposed for the origin of different types of variations have been critically examined. A theory of the origin of the variations is proposed, their connectionwith different geophysical-astrophysical phenomena is examined, F
in particular, with the properties of the solar corpuscular fluxes and 6
with electromagnetic conditions in the vicinity of the Earth, in the 0
atmosphere of the Sun, in interplanetary space and the galactics.

The book also contains the results of the author's theoretical works (47-51).

During the IGY and IGS period the effect on cosmic rays during magnetic storms was studied from data from more than 50 stations of the world network. The possibilities were studied of determining some parameters of the solar corpuscular fluxes on the basis of the type of lowering of intensity of cosmic rays during magnetic storms. It was shown that the profile of the lowering is determined basically by the geometry of the capture of the Earth by flux, which permits the study of the properties of individual corpuscular fluxes and their parameters.

Analysis was made of the effect of the growth in intensity before magnetic storms, from which the conclusion was drawn that the effect of the growth in intensity is created by the acceleration of particles at the time of their reflection from the leading edge of the corpuscular flux carrying the "frozen-in" magnetic field.

The work was carried out jointly with the magnetic laboratory of the USSR Academy of Sciences. The results of the investigations are given in the works (12-15). An analysis was made of the daily variations in intensity of cosmic rays on the basis of data from 10 stations. It was shown that during examination of changes in a solar-twenty-four hour period variation with a cycle of solar activity, the observed annual mean solar-twenty four hour period variation can be presented in the form of the sum of two components, from which one varies with solar activity and the second constant does not depend on solar activity. Evidence has been obtained that the variable component is connected with the anisotropy of the original radiation beyond the limits of the geomagnetic field, whereas the constant has an atmospheric origin (16, 17).

Processing of data on cosmic rays obtained in the Antarctic was carried out. Preliminary results showed that the observed variations of the hard component of cosmic rays in the village of Mirnyy have a somewhat large amplitude than at temperate latitudes. The greatest difference occurs in periods of increased magnetic activity (18).

Jointly with Moscow State University a study was made of observation data of the intensity of cosmic rays under the Earth at a depth of 40 m of water equivalent. Preliminary results are given in article (19).

In the Arctic and Antarctic Institute studies were made of seasonal, daily and 27 day variations in intensity of the hard component of cosmic rays on the basis of data from stations at Tiksi bay, Mys Schmidt, Moscow and Yakutsk during 1953-55. The role of temperature effect in daily, seasonal and 27 day variations is shown (20-21).

On the basis of data from the high-latitude observatories of Mys Schmidt and Tikhaya bay it was found that changes in intensity of cosmic rays at high latitudes in years of weak solar activity often have a local character, which is possibly connected with the incomplete elimination of temperature effects by the Feinberg-Dorman method.

Small increases in intensity were detected 2-3 days after polar magnetic storms (22).

From data obtained during 1958 at Kheisa Island and at Moscow with the use of a neutron monitor and a cubic telescope it was discovered that during magnetic storms which began gradually noticeable increases in cosmic ray intensity were observed, whereas during magnetic storms which broke suddenly drops in intensity were observed. The assumption was made that the detected increases in intensity of cosmic rays are the result of the generation on the Sun of high-energy cosmic rays during exceptionally high solar activity (23).

In the Yakutsk branch of the Siberian department of the USSR Academy of Sciences a complex of continuous observations of various components of cosmic rays on a wide band of energies from 2.10^9 to 54.10^6 ev [electron-volts] was produced at one point.

Measurements using counter telescopes are made at depths underground corresponding to 7.20 and 60 m of water equivalent; 5 instruments are working on the surface of the earth - a neutron monitor, two ionization chambers, a counter telescope and a unit for measuring broad atmospheric downpours. Surface and underground measurements are supplemented with episodic observations of the ionizing and neutron component on aircraft and sounding balloons.

The results of an analysis of this complex of observations are presented in a number of works produced by the co-workers of the Yakutsk branch (24-37).

In the magnetic laboratory of the USSR Academy of Sciences works was done together with IZMIRAN on the analysis of cosmic ray variations, connected with magnetic disturbances and corpuscular fluxes. A number of theoretical works was carried out concerning atmospheric effects in cosmic rays and the modulation of the original flux (38-44), (52, 67).

In the Physics Institute of the USSR Academy of Sciences named after Lebedev stratospheric studies showed the presence of large "flashes" of intensity of cosmic rays of very low energies (one hundred tev [thermal ? electron volts?) connected with magnetic storms, which were observed only at the Murmansk station at great heights and had no reflection at lower latitudes and in surface data. The expressed 27-day recurrence in the intensity of cosmic rays in the stratosphere which has been well expressed during the period from July 1957 to the middle of 1958 has been detected just as clearly (45).

In the Crimean Astrophysics Observatory, on the basis of data from a number of stations, the dependences of the amplitude and duration of the intensity drop (Forbush type) on the amplitude of the sudden outbreak of a magnetic storm were studied.

Asymmetry was found in the initial stage of fall-off, as well as the dependence of the hardness of the spectrum on the amplitude and the disturbance of the field before a sudden outbreak of a magnetic storm (46).

At the Caucasus State University work was done on the study of small flashes and the neutron component of cosmic rays.

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5. Investigation of Meteors

In connection with carrying out the IGY-IGS program work on the study of meteors increased. Using meteoric patrols photographs were obtained from two points of around 400 meteors (Stalinabad, Odessa, Kiev, Ashkhabad); there were recorded over 1,500,000 meteoric radio-echoes (Kazan', Khar'kov, Tomsk, Stalinabad, Odessa, Kiev) and radio direction finding observations of the drift of meteor trails were begun (Khar'kov).

Meteor photographs are used to obtain values of the density of the atmosphere by the usual method (according to the decleration and mass of the meteoric particle) and to determine the height of homogeneous atmosphere by a formula proposed by L. A. Katasev (1). Photographs of 80 meteors were developed.

A series of projects were executed on the study of the probability of meteoric ionization and its dependence on speed, which are important for explaining the effect of meteors on the ionosphere (2-3).

Radio direction finding equipment, developed for measuring the drift of meteoric trails, is described in an article by B. L. Lashcheev, I. A. Lysenko and V. F. Chepura (4).

A number of projects of Fialko E. I., Peregudova F. I., Txesevich V. P. and others is devoted to problems of processing radio direction finding observations of a number of meteors - to an account of the effect of meteor speeds, the shape of the antenna lobe, the length of the wave and other parameters of the locater, without which it is impossible to find the true flux of meteoric particles coming into the earth's atmosphere (5, 6, 7, 8, 9).

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